SEPTEMBER 1937

DEPARTMENT OF THE INTERIOR

UNITED STATES BUREAU OF MINES
JOHN W. FINCH, DIRECTOR

INFORMATION CIRCULAR

SHAFT- AND SLOPE-BOTTOM LAY-OUTS AT COAL MINES

RECEIVED
OCT 30 1937
O. S. U. LIBRARY

BY

ROBERT L. ANDERSON

AFTER THIS REPORT HAS SERVED YOUR PURPOSE AND IF YOU HAVE NO FURTHER NEED FOR IT, PLEASE RETURN IT TO THE BUREAU OF MINES, USING THE OFFICIAL MAILING LABEL ON THE INSIDE OF THE BACK COVER.

I.C. 6949.
September 1937.

INFORMATION CIRCULAR

DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

SHAFT- AND SLOPE-BOTTOM LAY-OUTS AT COAL MINES[1]

By Robert L. Anderson[2]

INTRODUCTION

A shaft or slope bottom is that portion of a mine that is contiguous to the bottom of the main hoisting shaft or slope. It includes the terminal tracks for loaded- and empty-car storage, locomotive run-arounds, locomotive shops, charging stalls, supply rooms, pump rooms, waiting rooms, and offices for dispatcher, weighmen, and foremen.

This paper will deal principally with the arrangement of tracks and the handling of cars on the bottom, but includes other data that may be affected, directly or indirectly, by the bottom lay-out. All of the mines discussed are being operated in comparatively level coal seams.

Twenty-one mines in five states were visited, and a brief description of each bottom arrangement is given. Comparative data are shown in tables 1 to 6, inclusive.

ACKNOWLEDGMENT

The information used in preparing this paper was obtained through the courtesy and cooperation of the officials of the mines examined.

GENERAL DESCRIPTION

Since the location of the shaft or slope bottom will affect haulage grades and drainage throughout the life of the mine, preliminary drilling usually is done to determine the contour of the coal bed. Other important factors in determining where to locate the shaft or slope are: tipple location with regard to railroad or river connections, adequate surface for plant buildings and waste disposal; the desirability of locating the shaft as near to the center of the property as the above factors will permit.

Pillars should be provided of sufficient size to protect the shaft or slope bottom and the surface plant.

---

[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6949."

[2] Associate mining engineer, coal-mining section, Mining Division, U. S. Bureau of Mines.

The shaft or slope bottom is the busiest place in the mine. Loaded cars are dumped or hoisted and the empty cars are returned to the working faces as fast as can be done economically and safely. Track and equipment are arranged so that handling the cars is flexible. Storage tracks are provided for both loaded cars and empty cars to permit the main-haulage locomotives to keep moving when short delays occur. Track grades on the bottom are usually in favor of the loaded cars, but the grades for the empty cars depend on the method of handling them.

There are three general operations in handling cars on the bottom: (1) moving loaded cars to the cage or dump from the place where they are left by the haulage-locomotive; (2) placing the loaded cars on the cage or dump; and (3) moving empty cars from cage or dump to storage tracks.

Moving Loaded Cars to Cage or Dump

The main-haulage locomotives place the cars on a grade that will permit them to run by gravity, or they are placed on an approximately level track to be handled by a car haul, a shunting locomotive, or a switching locomotive, which delivers the cars to the cage or dump.

If the loaded cars are permitted to run by gravity, they are controlled by brakes or sprags. Eleven of the mines visited handle loaded cars by gravity. (See mines 2 and 15 for track grades.)

Two types of car hauls (the chain haul and the compressed-air cylinder) are in use at the mines visited. The chain haul consists of an endless chain driven by an electric motor with push-button or automatic controls. The chains have attachments that engage the car axles, bumpers, or lugs attached to the cars. (See mines 9, 11, 12, and 14.) The compressed-air cylinder is described under mine 13.

At mines 1 and 18, a shunting locomotive runs on a track between the two loaded tracks and advances the cars by engaging a sliding arm with the bumper or the end of a car. Mines 6 and 20 use locomotives for advancing the loaded cars.

Caging or Dumping

Loaded cars are caged by hand or by an automatic caging device. Mines 6, 10, 15, and 19 employ hand caging, and the 10 others that have cage hoisting use automatic caging devices. Most of the cages are self-dumping and have an automatic locking device to hold the car in place while the cage is in motion. Figure 14 is a sketch of a type of automatic double-horn cager and a self-dumping automatic cage in use at some of the mines visited.

The automatic double-horn cager operates as follows: The landing of the cage strikes the trip crank, which opens the front horns of the caging device, allowing a loaded car to pass onto the cage and pushing an empty

Original from THE OHIO STATE UNIVERSITY

car off. At the same time, the rear horns close and hold the next loaded car. Front and rear horns are connected to a rocker shaft in such manner that when one set opens the other closes, and vice versa. As the cage rises, its weight is taken from the trip crank, a weight acts to revolve the rocker shaft, and the front horns are closed and the rear horns are opened, allowing the loaded cars to advance and stand against the front horns.

As the cage lands on the shaft bottom, it automatically releases the empty car on the cage, which is pushed off by the oncoming loaded car. There are two pairs of horns on the cage that embrace the wheels, and they operate independently of each other. (See fig. 14.) The front pair of horns is closed automatically as the front wheels of the oncoming loaded car pass the rear horns; and the rear horns are closed automatically as the front wheels of the car move up against the front horns.

When skips or conveyors are used for hoisting, the coal is dumped into a bin. It then passes by gravity to a measuring hopper and into the skip, or it is fed in a uniform flow onto the conveyor by a feeder.

A skip-hoisting-bottom installation is more expensive to install than a self-dumping-cage type, but fewer men are required for its operation. There is very little difference in the breakage of coal between a mine operated by a skip hoist and one operated by an automatic self-dumping cage.3/

Three types of dumping are in use on the bottoms of the mines visited-the rotary, cross-over, and automatic drop-bottom cars. The rotary dumps may make a complete revolution or turn part way and then back. They are operated by electric motors or compressed air (see mines 11 and 13.) (There are gravity-type rotary dumps and kick-back-type dumps, but neither of these types was noted at the mines visited.) The cross-over dump is of the gravity type (see fig. 7). Drop-bottom-type mine cars are used at mine 21.

Movement of Empty Cars to Storage Tracks

At 12 of the 21 mines visited, the empty cars are moved by gravity alone, at 4, locomotives are used on an approximately level track, and at 5 a car-lift or car-feeder and gravity combined is used. Mines 10 and 15 alone of the group use a kick-back.

3/ Allen, Andrews, and Garcia, John A., Skip Hoisting for Coal Mines: Trans. Am. Inst. Min. Eng., vol. 66, 1921, pp. 370-396.

DESCRIPTION OF BOTTOM LAY-OUTS

The following is a description of the shaft and slope bottoms on which data were collected. Mines 1 to 7, inclusive, are in Pennsylvania; 8 to 14, inclusive, are in West Virginia, 15 is in Kansas, 16 to 19, inclusive, are in Illinois, and 20 and 21 are in Indiana. Comparative data are shown in tables 1 to 6, inclusive.

Mine 1

This property was drilled extensively to determine the elevation, thickness, and quality of the coal before the mine projection and shaft bottom were laid out in 1918.

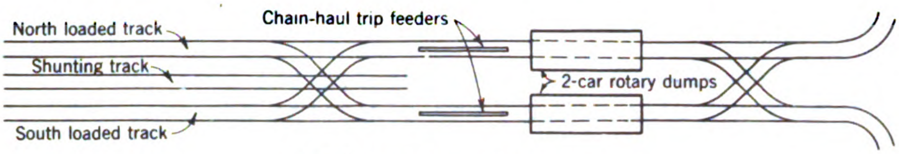
A 25-foot reinforced-concrete arch about 1,400 feet long protects the main body of the shaft bottom. This consists of three parallel, approximately level tracks, as shown in figure 1. The average production per shift is 5,600 tons.

A dispatcher controls, by telephones, all the movements of the entire haulage system. Every side track has a telephone. Coal is gathered with 8-ton cable-reel locomotives, and 13-ton trolley locomotives are used from the inside storage tracks or partings to the shaft bottom. Main-line locomotives bring the loaded trips in on the outside tracks of the three parallel tracks and pull them up until they are near the preceding loaded trip. The locomotives uncouple and proceed through the cross-over to the north or south empty track for the return trip of empties.

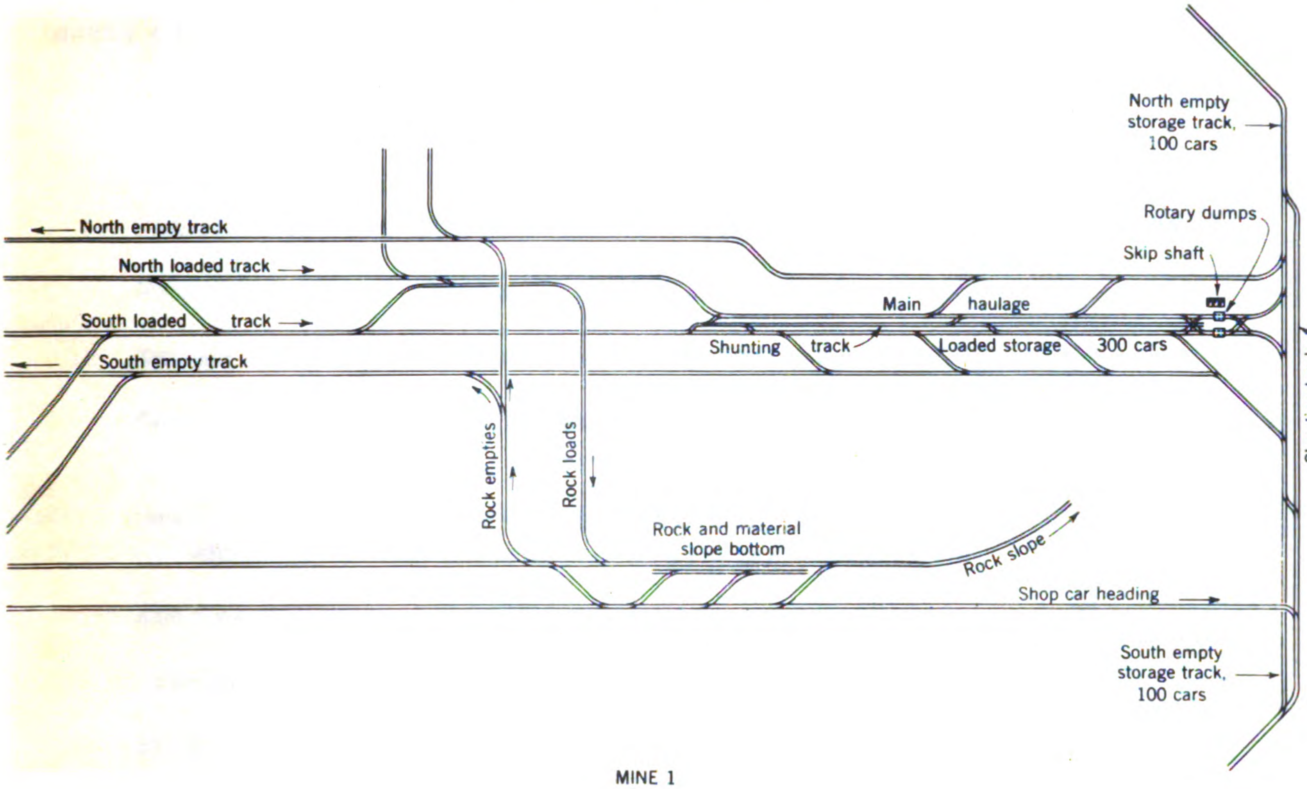
A 13-ton shunting locomotive, equipped with a sliding arm that can be extended either to the right or to the left, engages the bumper of the mine car and advances the incoming loaded trips to the chain-haul trip feeders. The trip feeders advance the loaded cars onto the rotary dumps, where the cars are dumped without being uncoupled. Each of the two loaded tracks has a trip feeder and a rotary dump, but the coal is all dumped into one bin. The rotary dumps make a complete revolution and dump two cars at one operation. Either of the two dumps can be operated independently of the other, and when the mine operates at reduced capacity only one dump is used. The capacity of each dump is one operation every 30 seconds, or about 860 tons per hour.

The hoist is automatic and has push-button controls both on the shaft bottom and surface. The dumper controls the hoist unless there is some reason on the surface to stop it. Electric signal lights indicate the position of the skip loading gates and of the skip being loaded. Figure 9 shows a skip-loading station.

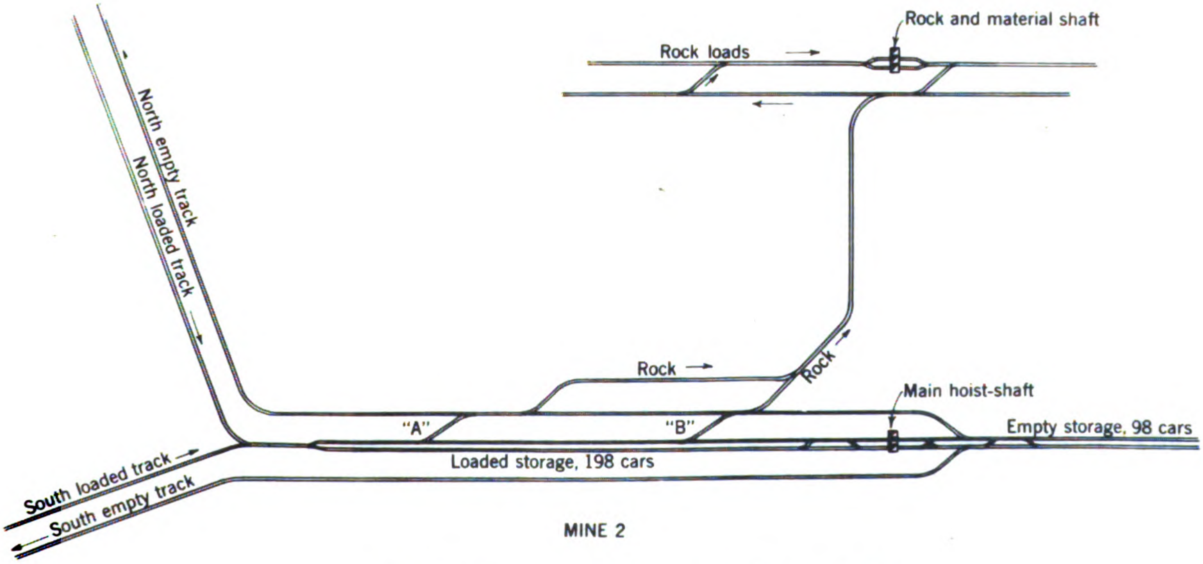
Concentrated block system of mining is used, in which entries, rooms, and crosscuts are driven 12 feet wide on 100-foot centers. Practically all coal is machine-cut. Loading is done by hand.



Detail of tracks near rotary dumps



MINE 1



MINE 2

Figure 1.—Sketch showing arrangement of tracks at shaft bottom.

Rock and house coal are hoisted by means of rope-haulage through a rock slope. Supplies and materials are brought into the mine through this slope. The loaded rock cars coming in to the slope cross the south loaded and south empty tracks by means of overhead crossings. The cars returning from the slope into the mine, to the north section, cross the south empty and south and north loaded tracks on overhead crossings.

A separate man-hoist is maintained with a double-deck cage.

Summary, Mine 1

Coal hoisted per shift	cars,	1,555, (5,600, tons)
Rock hoisted per shift	do,	200
Number of bottom employees handling coal		5
Coal per shift per bottom employee handling coal	tons,	1,120
Coal per shift per bottom employee handling coal, rock, and materials	do	622
Average mine-car turn-over		1.03
Average number of cars per trip		40
Average track grade against loads		approximately level

Mine 2

This operation was originally planned for two separate mines but it is now worked as one mine. There are two shaft bottoms, about 800 feet apart; one is used for coal hoisting and the other for rock, supplies, and men. The average production per shift is 2,700 tons.

Room-and-pillar mining system in panels is used with 14-foot rooms on 60-foot centers. Loading is done by hand. All coal except the stumps is cut by machines. Coal is cut at the top.

Animal haulage and battery locomotives are used for gathering. The main-line haulage consists of four 15-ton locomotives. A dispatcher is in touch with all partings by telephone.

The loaded trips enter the bottom at the double track, and the locomotive uncouples and takes the cross-over at "A" or "B", as shown in figure 1. The loaded track is graded $1\frac{1}{2}$ to 2 percent in favor of the loads, and a loaded trip can be dropped by gravity on either side of the double track. Two droppers are required for this operation. One dropper uncouples the cars and drops them down to the other dropper, who alternates the loads from different parts of the mine to give a uniform product. (Coal from different sections in the mine is of different quality.) One man, with the aid of a double-horn automatic cager, places the cars on the self-dumping cage. (See fig. 14.)

Two couplers make up the empty trips, which are picked up by the locomotives for the return on either the north or south empty track.

Three bottom employees - motorman, coupler, and cager - handle rock, supplies, and men. A 10-ton locomotive is used for handling rock and supplies.

Summary, Mine 2

Coal hoisted per shift....................	cars,	900 (2,700 tons)
Rock hoisted per shift	do	200
Number of bottom employees handling coal.......		5
Coal per shift per bottom employee handling coal...................................	tons	540
Coal per shift per bottom employee handling coal, rock, and materials	do	337
Average mine-car turn-over.................		1.37
Average number of cars per trip		42
Average track grade against loads.........	percent	1.7

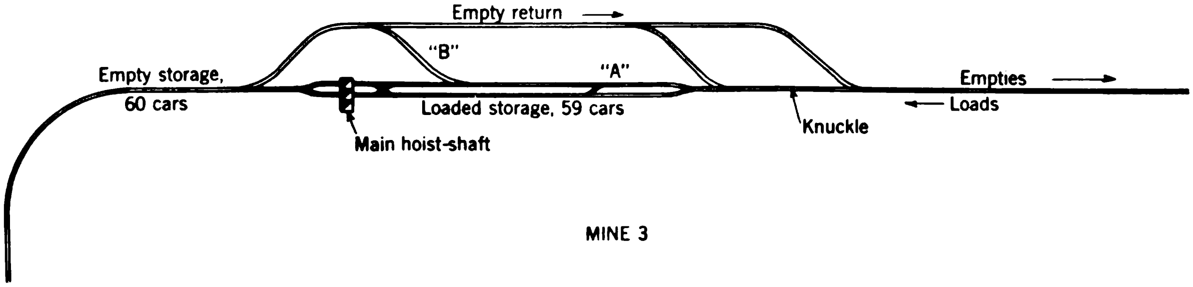
Mine 3

Average production per shift is 1,950 tons. The main shaft is also used for hoisting rock. A 14-degree rock slope, 750 feet long, is used for a man and material way.

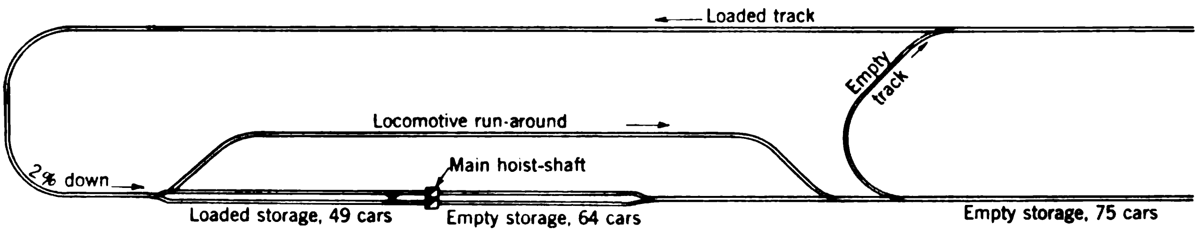
Animal haulage is used in gathering coal. Room-and-pillar mining system is used, with panels 1,200 to 1,500 feet long. Rooms 21 feet wide and 300 feet long are driven on 46- or 50-foot centers. Practically all coal is undercut by machines. Draw slate, averaging about 12 inches, is taken down and gobbed in the rooms but hauled out from the entries.

Main-line locomotives pull the loaded trips of 20 to 60 cars onto the bottom to point "A" where they uncouple and take the cross-over, "B", to pick up empty trips. (See fig. 2.) Loaded cars are dropped by gravity to the automatic cager.

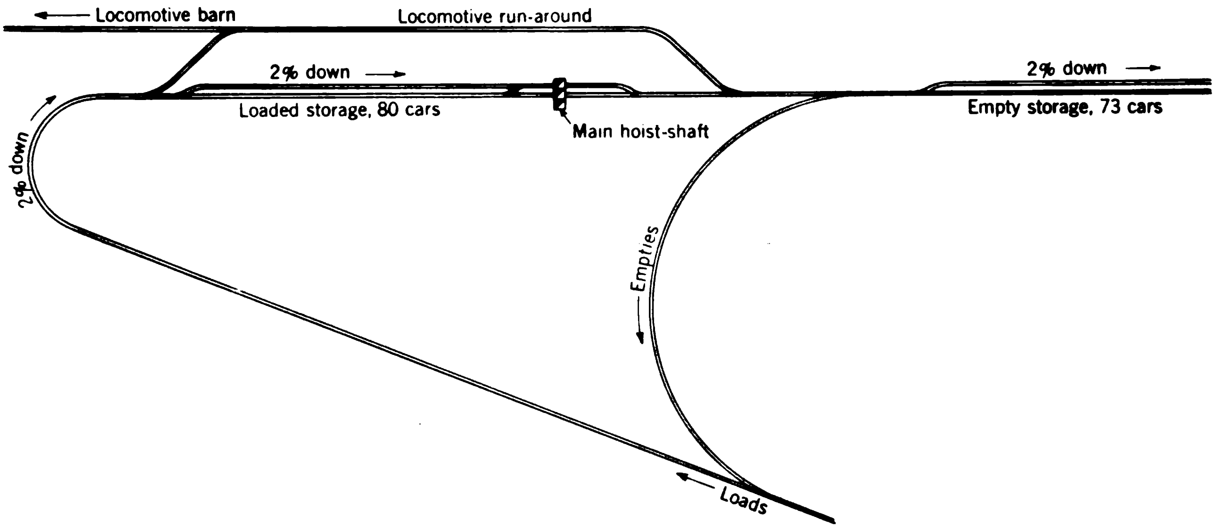
Original from THE OHIO STATE UNIVERSITY



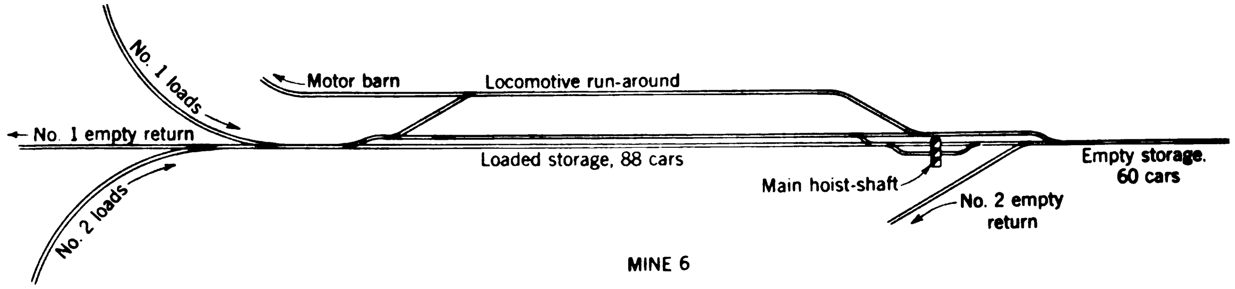
MINE 3



MINE 4



MINE 5



MINE 6

Figure 2.—Sketch showing arrangement of tracks at shaft bottom.

Summary, Mine 3

Coal hoisted per shift	cars,	720 (1,950 tons)
Rock hoisted per shift	do	60
Number of bottom employees handling coal		4
Coal per shift per bottom employee handling coal	tons,	487
Coal per shift per bottom employee handling coal, rock, and materials	do	487
Average mine-car turn-over		1.76
Average number of cars per trip		36
Average track grade against loads	percent	.8

Mine 4

This mine has been in operation a number of years. The average production per shift is 600 tons. Room-and-pillar system of mining is used with rooms 20 feet wide on 60-foot centers and 150 to 200 feet long. Coal is cut by machine and loaded by hand. Coal is gathered by locomotive and animal haulage.

Bottom arrangement is laid out so that the loaded cars can be dropped by gravity, although the main body of the coal dips away from the shaft. (See fig. 2.) Loaded trips are delivered to the double track, and the locomotive takes the run-around and picks up the empty trip and returns along "empty track."

Summary, Mine 4

Coal hoisted per shift	cars,	300 (600 tons)
Rock hoisted per shift	do	45
Number of bottom employees handling coal		2
Coal per shift per bottom employee handling coal	tons,	300
Coal per shift per bottom employee handling coal, rock, and materials	do	300
Average mine-car turn-over		1.97
Average number of cars per trip		27
Average track grade against loads	percent	1.0

Mine 5

Average production per shift is 1,500 tons. All coal is gathered by means of animal haulage. Mining system is the regular room-and-pillar, with rooms 18 feet wide, 200 feet long, and on 50-foot centers. Coal is cut by machine and loaded by hand. . . . . .

The loaded trips are pulled around the curve until the locomotive reaches the run-around. (See fig. 2.) This places the cars on a 2-percent grade and they are dropped by gravity to the cager, who cages them with an automatic cager. The locomotive takes the run-around to the empty storage track and returns along the track marked "empties."

Summary, Mine 5

Coal hoisted per shift	cars,	750 (1,500 tons)
Rock hoisted per shift	do	60
Number of bottom employees handling coal		4
Coal per shift per bottom employee handling coal	tons,	375
Coal per shift per bottom employee handling coal, rock, and materials	do	375
Average mine-car turn-over		1.31
Average number of cars per trip		34
Average track grade against loads	Approximately level	

Mine 6

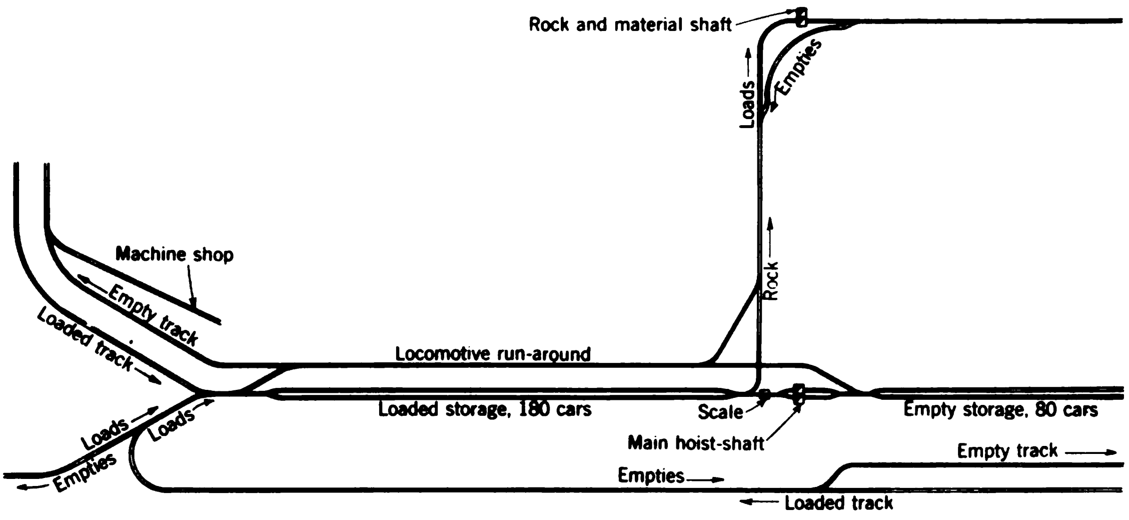
This mine was opened about 35 years ago. The main hoist-shaft is used for rock and materials and also for lowering and hoisting men.

Average production is 3,100 tons per shift. Room-and-pillar panel system of mining is used. Rooms 20 feet wide and 250 feet long are driven on 90-foot centers. All the coal is undercut by mining machines except a small amount of pillar work. Loading is done by hand.

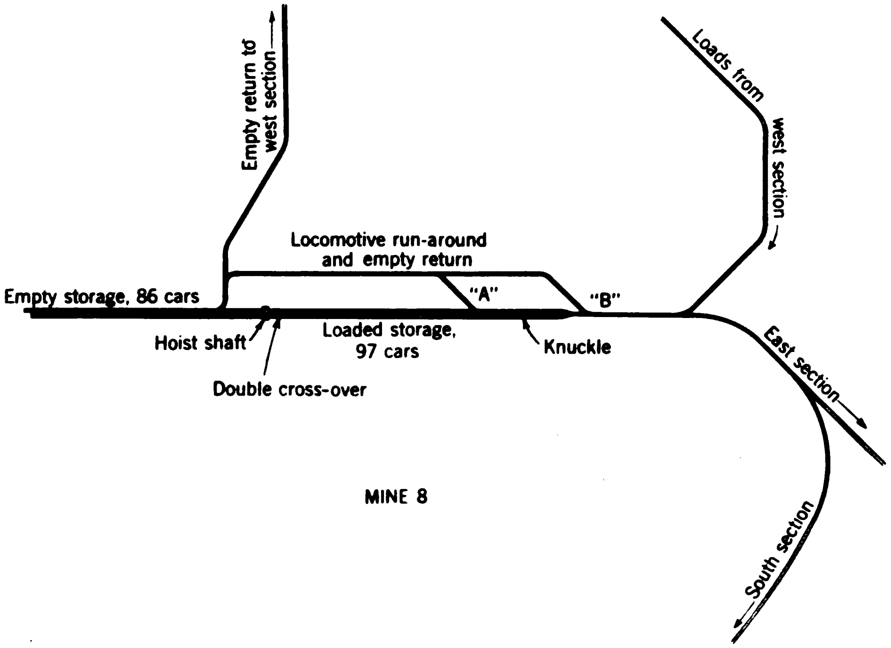
Crab-reel locomotives are used for gathering. There are four main-line haulage units, and each consists of two 10-ton locomotives in tandem. Main-haulage trips are made up of 40 to 60 cars. No. 1 empty trips return from storage track by way of locomotive run-around.

Two locomotives are used on the shaft bottom - one on the loaded side and the other on the empty side to make up empty trips. (See fig. 2.)

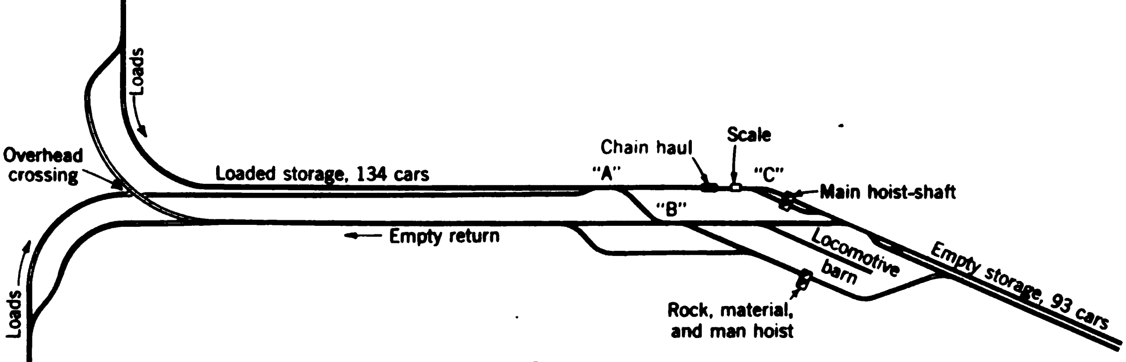
Original from THE OHIO STATE UNIVERSITY



MINE 7



MINE 8



MINE 9

Figure 3.–Sketch showing arrangement of tracks at shaft bottom.

Summary, Mine 6

Coal hoisted per shift	cars,	1,030 (3,100 tons)
Rock hoisted per shift	do	120
Number of bottom employees handling coal		7
Coal per shift per bottom employee handling coal	tons	443
Coal per shift per bottom employee handling coal, rock, and materials	do	443
Average mine-car turn-over		1.50
Average number of cars per trip		50
Average track grade against loads	Approximately level	

Mine 7

This mine was opened about 30 years ago. The main hoist-shaft is used for hoisting coal only. A second shaft, about 800 feet from the main shaft, is used for rock, materials, and lowering and hoisting men. Average production per shift is 3,000 tons.

The mining system is room-and-pillar in panels, with rooms 18 feet wide, 250 feet long, and on 90-foot centers. Practically all the coal is undercut by mining machines. Loading is done by hand.

Coal is gathered by storage-battery, crab-type, and cable-reel locomotives. Main-haulage trips of 35 to 40 cars are pulled to the double track on the bottom, where the locomotive takes the run-around. (See fig. 3.) The loaded cars are dropped by gravity on either side of the double track, which is graded $1\frac{1}{2}$ to 2 percent in favor of the loads.

Summary, Mine 7

Coal hoisted per shift	cars,	1,000 (3,000 tons)
Rock hoisted per shift	do	170
Number of bottom employees handling coal		7
Coal per shift per bottom employee handling coal	tons	428
Coal per shift per bottom employee handling coal, rock, and materials	do	333
Average mine-car turn-over		1.17
Average number of cars per trip		37
Average track grade against loads	percent	minus 0.5

Original from THE OHIO STATE UNIVERSITY

Mine 8

Room-and-pillar system of mining is used, with rooms 25 feet wide on 75-foot centers and 300 feet long. Average production is 1,950 tons per shift. Coal is undercut by machines and loaded by hand. All of the tonnage comes from two main sections of the mine.

The roof above the coal is generally shale or sandstone, and the 4 inches shown in table as "average thickness of draw slate" refers to small areas of the mine in which the draw slate occurs.

Cable-reel locomotives are used for gathering and the main haulage trips consist of 25 to 30 cars each. The dispatcher has an office on the bottom near the hoist shaft, and with telephone connections to each side track he controls the movements of the entire haulage system. He keeps a record of each gathering and main-line locomotive, showing time of leaving and arriving and number of empty or loaded cars on every trip during the shift.

On entering the bottom, loaded trips are pulled over the knuckle, and the locomotive uncouples and takes the cross-over "A" to the empty storage tracks. (See fig. 3.) All empty return trips except those to the west section pass over the empty return and come onto the main track at "B". The empty return to the west section joins the main track several hundred feet from the bottom.

Summary, Mine 8

Coal hoisted per shift	cars,	650 (1,950 tons)
Rock hoisted per shift	do	125[1]
Number of bottom employees handling coal		4
Coal per shift per bottom employee handling coal....................	tons,	487
Coal per shift per bottom employee handling coal, rock, and materials	do	[2]
Average mine-car turn-over		1.47
Average number of cars per trip.......		27
Average track grade against loads....	percent	1.0

---

[1] Hold for night shift or idle day.

[2] Not available. Rock is hoisted at night shift or on idle day.

Mine 9

Room-and-pillar system of mining is used with rooms 20 feet wide on 60- to 90-foot centers and 350 feet long. Coal is undercut with machines and loaded by hand. Average production is 3,400 tons per shift. Cable-reel locomotives are used for gathering. Main-line trips average 40 cars each, but when the car supply is low the number of cars per trip is reduced.

The loaded trips come from two opposite sections of the mine and run onto the bottom on parallel tracks to point "A", where the two tracks come together. (See fig. 3.) The locomotives uncouple and take the cross-over "B" to the empty storage tracks. The loaded cars run by gravity to the chain haul, which feeds them onto the scale. The loads, on passing over the scale, run by gravity over an alternating switch to the automatic cager. Just before the loaded cars run onto the cages, they pass under a spray of water. This helps to keep down the dust in the tipple while dumping is being done. Although the loaded storage tracks show a capacity of 134 cars, there is room for only 20 cars between points "A" and "C". Each trip on the double track is cleared before another locomotive can get through on that track. One locomotive is kept at the shaft bottom to make up the empty trips. This "bottom" locomotive advances down the storage tracks and holds the empty cars as they come off the cages until a trip is made up. A main-line locomotive then couples onto the front of the trip and pulls, while the "bottom" locomotive pushes until the cars clear the storage tracks.

The item of 1½ men shown as "bottom employees handling rock and materials" includes one cager and one-fourth the time of a boss and of a general helper.

Summary, Mine 9

Coal hoisted per shift	cars,	750 (3,400 tons)
Rock hoisted per shift	do	78
Number of bottom employees handling coal		7.5
Coal per shift per bottom employee handling coal.........................	tons,	453
Coal per shift per bottom employee handling coal, rock, and materials...	do	378
Average mine-car turn-over		1.65
Average number of cars per trip.........		40
Average track grade against loads.......		Approximately level

Mine 10

The room-and-pillar system of mining is used with rooms 28 feet wide on approximately 80-foot centers and 350 feet deep. All coal is undercut by machines and loaded by hand. Average production per shift is 1,050 tons.

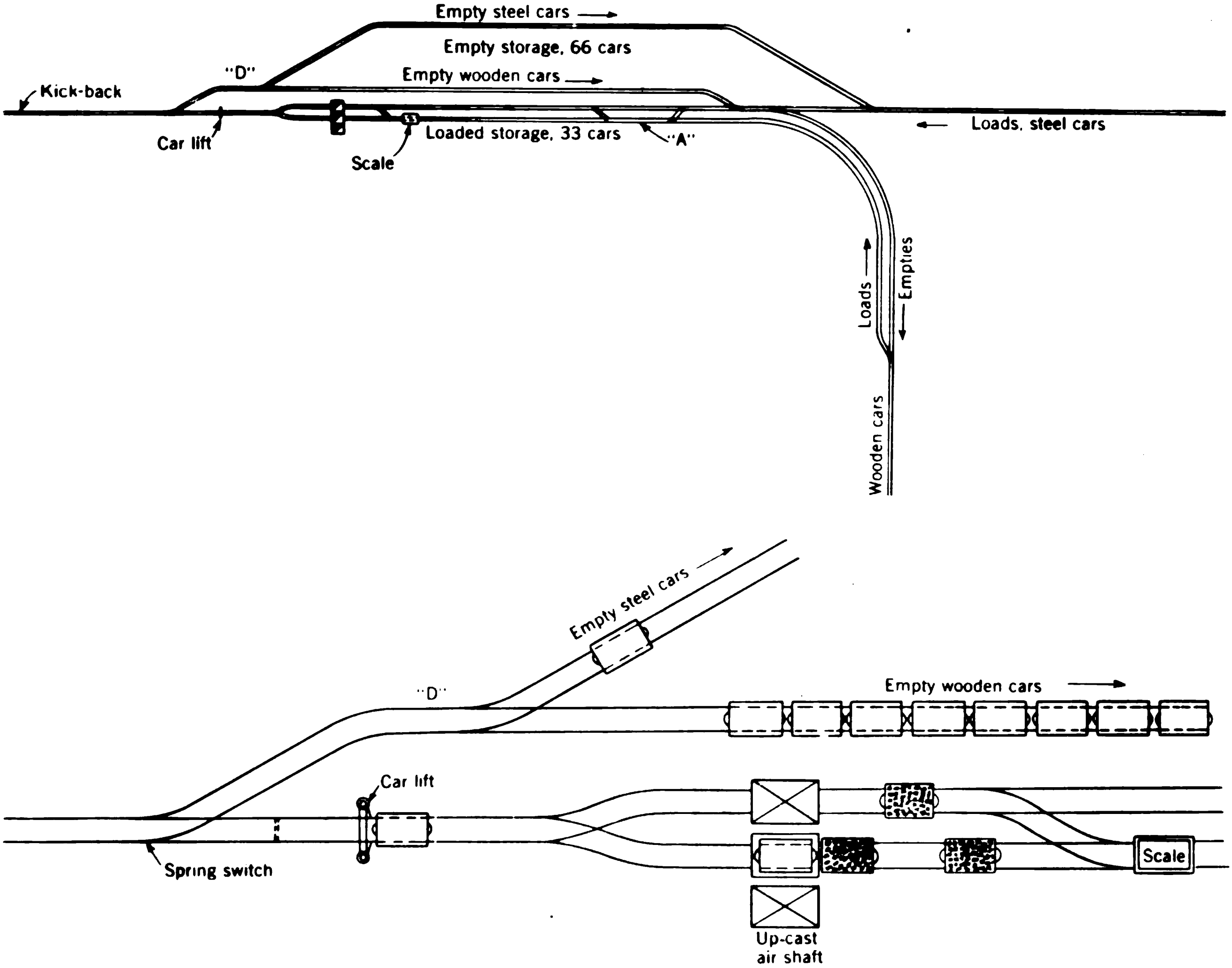
Cable-reel locomotives are used for gathering. Main-line track has a few grades of 5 percent against the loads, but the distance is very short. Two types of mine cars are in use - steel cars with low height for use in one section of the mine where coal is low and wooden cars for use in the other section where coal is higher. Loaded trips are pulled onto the bottom to point "A" and the locomotivesuncouple and cross over to the other track and back switch to the empty storage track. (See fig. 4.) The loaded cars run by gravity over the scale and are caged by hand. The empty cars on leaving the cage run by gravity to the automatic steam car-lift. As the car runs onto the lift, valve "B" is opened and the steam jack lifts the car so it will kick back and run by gravity onto empty storage tracks. As the car runs off the lift, valve "D" is closed, thereby lowering the lift for the next car. Empty steel cars are stored on one track and the wooden cars on the other storage track. Switch "D" is thrown by the empty car coupler when the cars of one type have been hoisted and they change to the other. One locomotive is kept on the shaft bottom for switchi

Summary, Mine 10

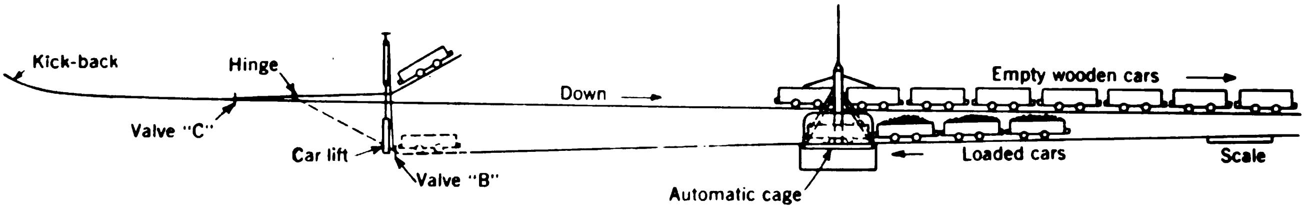
Coal hoisted per shift .... cars,	390 (1,050 tons)
Rock hoisted per shift	None
Number of bottom employees handling coal	5
Coal per shift per bottom employee handling coal .... tons,	210
Coal per shift per bottom employee handling coal, rock, and materials do	210
Average mine-car turn-over	1.30
Average number of cars per trip..........	25
Average track grade against loads.......	Approximately level

Mine 11

This mine, opened in 1929, is using an adaptation of the panel system with advancing and retreating robbing. The robbing line advances or retreats usually in a diagonal straight line across the panel. In some panels the pillars are drawn on the advance and in others they are drawn on the retreat. Rooms 18 to 20 feet wide and 400 feet long are driven on 50-foot centers. All coal is cut by machines and loaded by hand. Average production per shift is 1,700 tons.



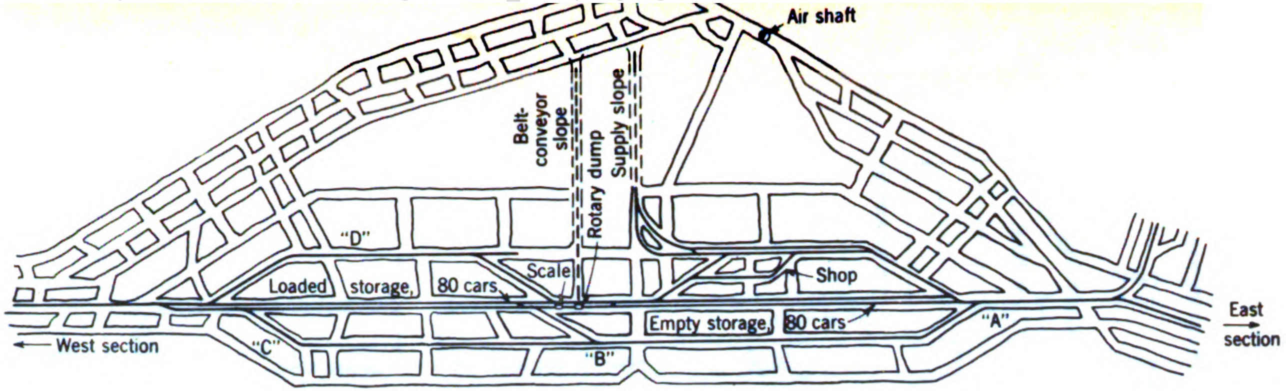
Enlarged plan near shaft



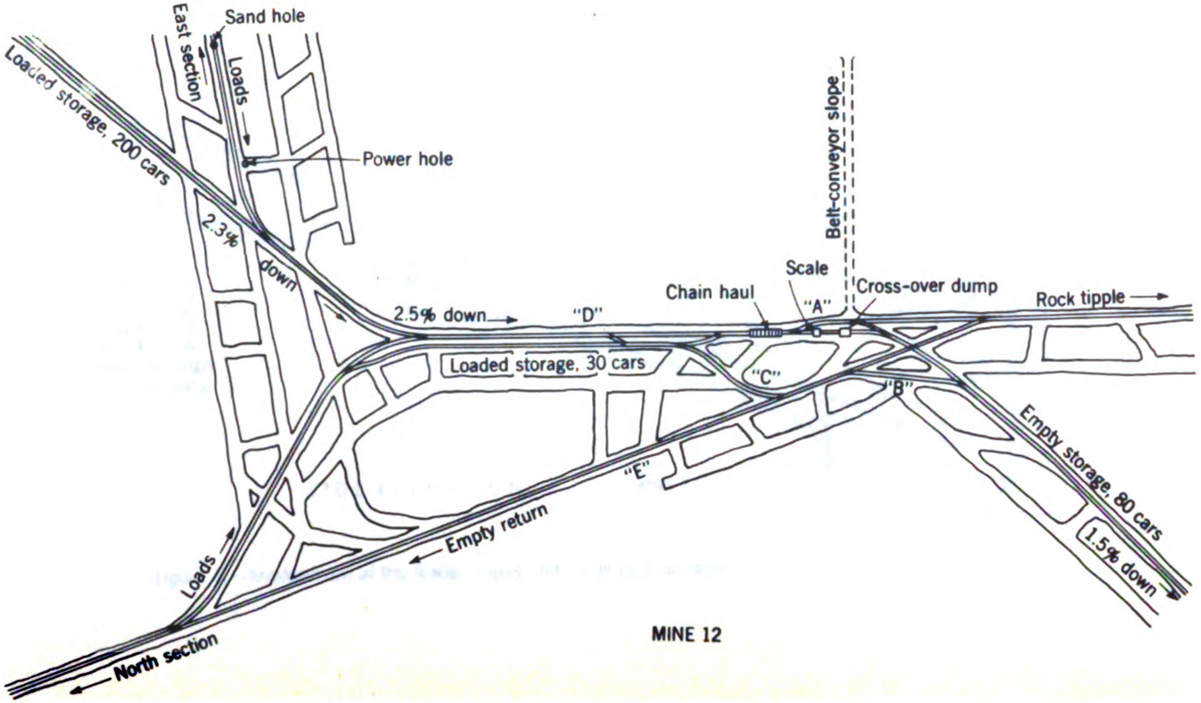
MINE 10

Enlarged elevation near shaft

Figure 4.–Sketch showing arrangement of tracks at shaft bottom.



MINE 11



MINE 12

Figure 5.–Slope-bottom lay-out, showing arrangement of tracks.

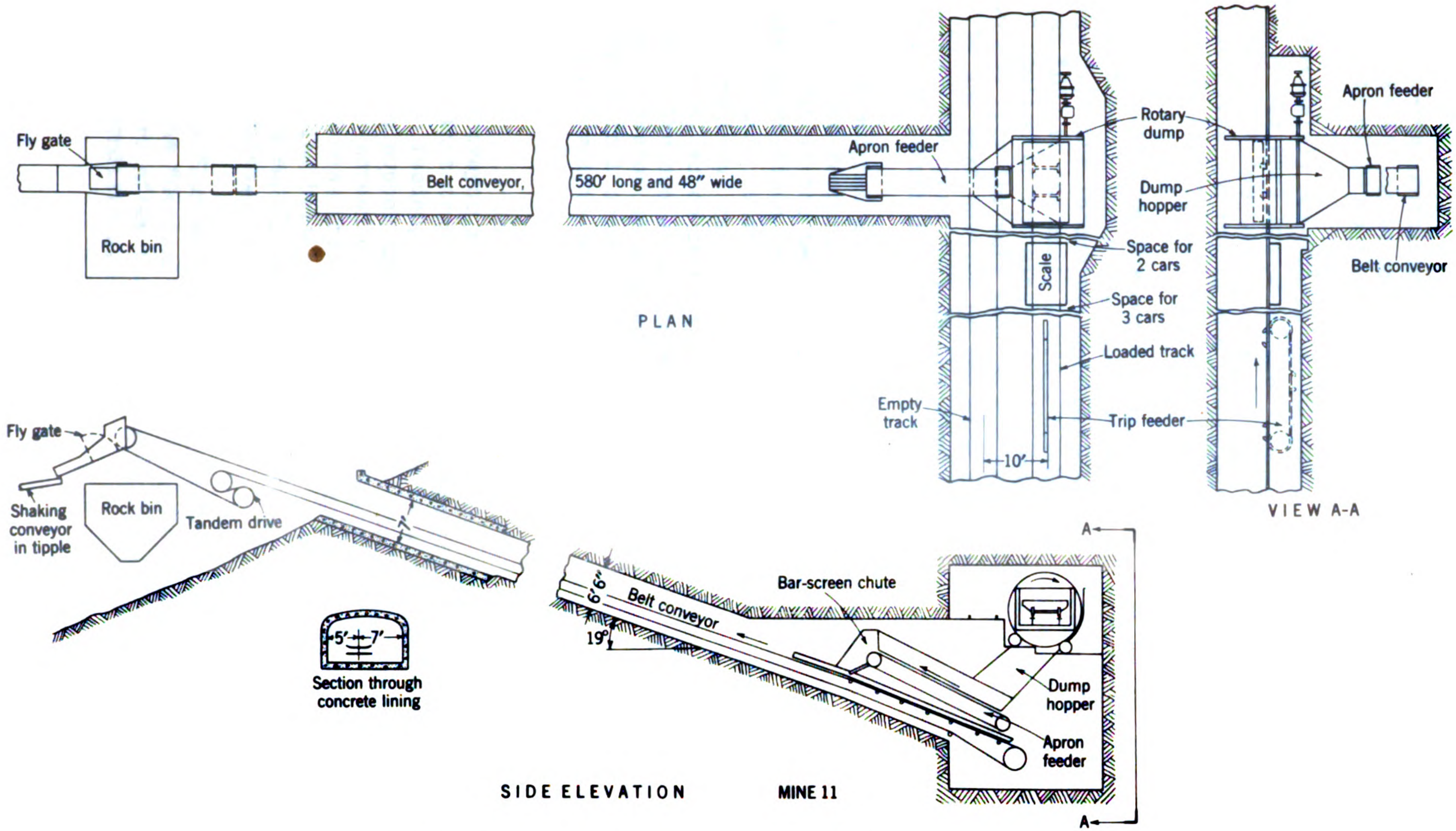


Figure 6.—Arrangement of trip feeder, rotary dump, and belt conveyor.

A cable-reel gathering locomotive is used for each parting, and an additional gathering locomotive is used to make up trips. A main haulage trip consists of 10 to 12 cars.

Approximately one-fourth of the loaders work on the night shift. In addition to the cars loaded at night, a number of cars either were loaded on the day shift too late to dump or were in transit at the close of the day. This gives the bottom men loaded cars to start on at the beginning of the day shift. The tipple runs only one 7-hour shift per day.

Loaded trips from the east section of the mine take the run-around at "A" and go through the cross-over "B" onto the south loaded storage track. (See fig. 5.) The locomotive uncouples and returns, by way of the run-around at "C", to the empty storage tracks. Empties and loads to and from the east section of the mine use the south track of the double tracks and those to and from the west section use the north track. Empty trips returning to the west section of the mine are made up on the north empty storage track and pass through the run-around "D". The scale and rotary dump are on the south track.

Cars are weighed and dumped without being uncoupled. To take the pressure off the couplings while the cars are being weighed, a slight depression is cut in the ball of the rail for the wheels of the cars to rest in. These depressions are made for all wheels on three cars above the scale and two cars below. The rails on the scale are cut for only two wheels - a front and rear on opposite sides. These two depressions cause the car to rock, which is an indicator to the weighman that the car is on the center of the scale and there is no pressure on the couplings. The rotary dump, powered by an electric motor, makes one complete turn, dumping one car of coal or rock at each operation. When rock is to be dumped, the belt is allowed to be clear of coal for at least 50 feet before the rock is dumped. This allows the men in the tipple time to open the fly-gate.

The belt conveyor is on a 19-degree slope and 580 feet long. It has a 48-inch belt that travels 350 feet per minute. Figure 6 shows the arrangement of the trip feeder, rotary dump, and belt conveyor. The coal or rock is dumped into a hopper and is conveyed to the belt by means of an apron feeder. The bar screen chute at the discharge end of the feeder allows the fine coal to pass through and form a layer that protects the belt from rolling lumps. The belt-conveyor slope is used as a manway. Supplies are lowered through a supply slope that has track connections to each end of empty storage tracks. (See fig. 5.)

In the table "Number of bottom employees handling coal," one employee is shown under the "General" heading. This man shovels out wet coal that sticks to the cars after they have been dumped and would not be required under ordinary conditions.

Original from THE OHIO STATE UNIVERSITY

Summary, Mine 11

Coal hoisted per shift	cars,	485 (1,700 tons)
Rock hoisted per shift	do	73
Number of bottom employees handling coal.		3
Coal per shift per bottom employee handling coal	tons,	566
Coal per shift per bottom employee handling coal, rock, and materials ...	do	566
Average mine-car turn-over		2.87
Average number of cars per trip		12
Average track grade against loads		Approximately level

Mine 12

This mine was operated as a drift mine for a number of years before the slope conveyor was installed 10 years ago. The old coal tipple is now used as a rock tipple.

Rooms are driven 22 feet wide and 400 feet long on 60-foot centers. All coal is undercut by machines and loaded by hand. The production averages 1,900 tons per shift. About one-third of the loaders work on the night shift. Cable-reel locomotives are used for gathering - 10 on the day shift and 6 at night. Main-haulage units and the tipple operate on the day shift only. Main-line haulage grades are very steep, averaging about 4 percent against the loads. Two 10-ton locomotives in tandem are used on each of the four main-haulage units. The dispatcher's office in on the main haulage about 1 mile from slope bottom. He has a telephone connection to each parting and the bottom.

Loaded trips coming onto the bottom from the north section of the mine pull down either of the double tracks to the chain haul. (See fig. 5.) The locomotive uncouples and takes the run-around at "A" to the empty storage tracks. Empty trips return along "B" - "E". The chain haul places the cars on the scale, and they are uncoupled before being weighed. Loaded cars run by gravity from the scale to the cross-over dump and onto the empty storage track.

As the loaded car passes onto the dump, it trips the horns and bumps the empty car off the dump. The loaded car is caught by the horns, and the dump is held by a brake, which, when released, allows the car to dump. The car and dump are righted by weights and are ready to repeat the operation. (See fig. 7.)

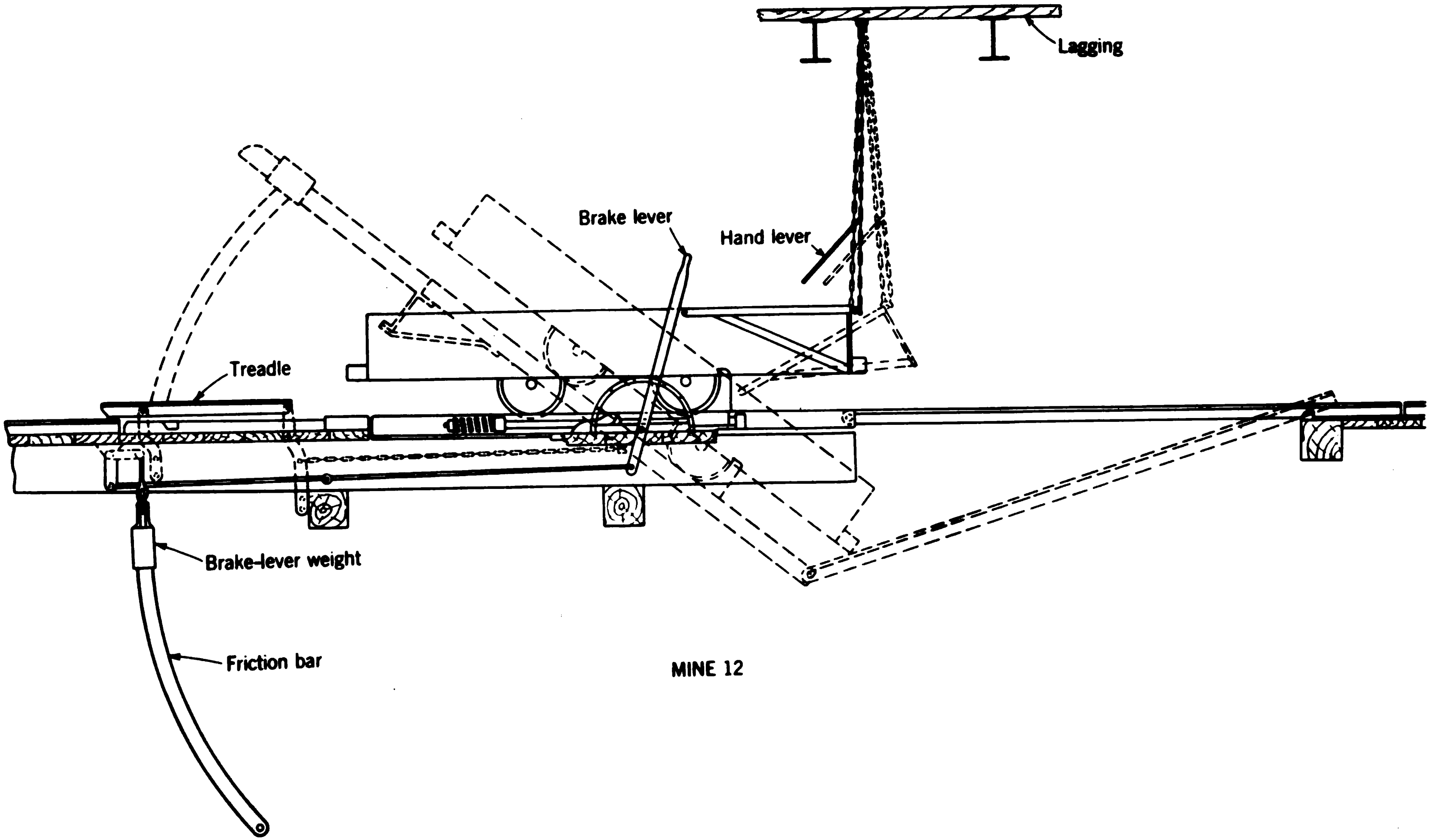


Figure 7.—Sketch showing cross-over-type dump.

The track on the bottom is downgrade, as follows: 1.5 percent on double track from "D" to chain haul, 1.0 percent chain haul to scale, 3.5 percent scale to dump, 2.5 percent dump to crossing, 1.5 percent crossing to end of empty storage track. (See fig. 5.) Storage is provided for 200 loaded cars in case of delays on the conveyor or tipple. At present, all the production is coming from the north section of the mine. Loaded trips from the east section can use only one of the double tracks, and empty trips return along "B" - "C" - "D".

Power lines enter the mine through a borehole 45 feet deep, and sand for the locomotives is poured through a hole 40 feet deep.

The slope conveyor is 290 feet long on an 18° slope. It is equipped with a 42-inch belt, which travels 250 feet per minute.

Summary, Mine 12

Coal hoisted per shift	cars,	730 (1,900 tons)
Rock hoisted per shift	do	63
Number of bottom employees handling coal.	,	5
Coal per shift per bottom employee handling coal	tons,	380
Coal per shift per bottom employee handling coal, rock, and materials ...	do	380
Average mine-car turn-over		1.98
Average number of cars per trip		22
Average track grade against loads	percent,	4.0

Mine 13

Development of this mine was begun in 1925. The block system of mining is used, with rooms 15 feet wide on 60- to 75-foot centers, and 720 feet long. All coal is cut by machines and loading is done by hand. Average production per shift is 3,500 tons.

Cutting machines, gathering locomotives, and main-haulage locomotives operate on storage batteries. Main-haulage locomotives normally change batteries every 4 hours. Charging time is about twice as long as running time. Batteries for the cutting machines are transported to and from the charging stalls on a truck. This portable power unit operates on 250 volts, the main-line locomotives on 275 volts, and gathering locomotives on 140 volts. The battery compartment on all units is a separate component part that is easily attached or detached from the chassis. The locomotive enters a stall where one charging rack is empty and deposits its exhausted battery. Then the chassis backs out and runs under a rack on which there is a charged battery. The chassis obtains power from a cable to change from one stall to another. Battery water is piped down the shaft from stills on the surface to storage tanks on the bottom and thence to water-hose connections at the charging stalls.

There are three shafts on the bottom (see fig. 8). The air enters the mine through the main air shaft and is discharged up the skip shaft and the man, rock, and material shaft. Loaded trips come onto the bottom and pull around toward the loaded storage tracks and back switch to the rotary dump. The locomotive takes the run-around at "A" and picks up the empty return trip. The loaded cars run by gravity from the locomotive run-around to the first car feeder and are coupled to the loaded cars being dumped. (See fig. 9.) There are two car feeders - one on each side of the dump. They consist of cylinders placed in the center of the track. They are operated by compressed air, each cylinder having a stroke a little more than the length of a mine car. The piston rod engages a lug on the bottom of the mine cars. Two cars are dumped at one time by a rotary dump operated by compressed air and turning an arc of 150°. During the dumping operation, the car feeders pull in opposite directions, holding the couplings in tension so that the pins will not fall out. Each car dumps into a separate weigh pan and thence into a separate measuring chute, which holds three carloads or one skipload. One locomotive and crew handles rock and supplies, which are hoisted or lowered through a separate shaft.

Summary, Mine 13

Coal hoisted per shift	cars,	700 (3,500 tons)
Rock hoisted per shift	do	100
Number of bottom employees handling coal.		3
Coal per shift per bottom employee handling coal	tons,	1,167
Coal per shift per bottom employee handling coal, rock, and materials	do	700
Average mine-car turn-over		1.31
Average number of cars per trip		45
Average track grade against loads	Approximately level	

Mine 14

Room-and-pillar system of mining is used, with rooms 16 to 18 feet wide, driven 400 feet long on 90-foot centers. All loading is done by hand, and the average production per shift is 1,600 tons. Coal is cut at

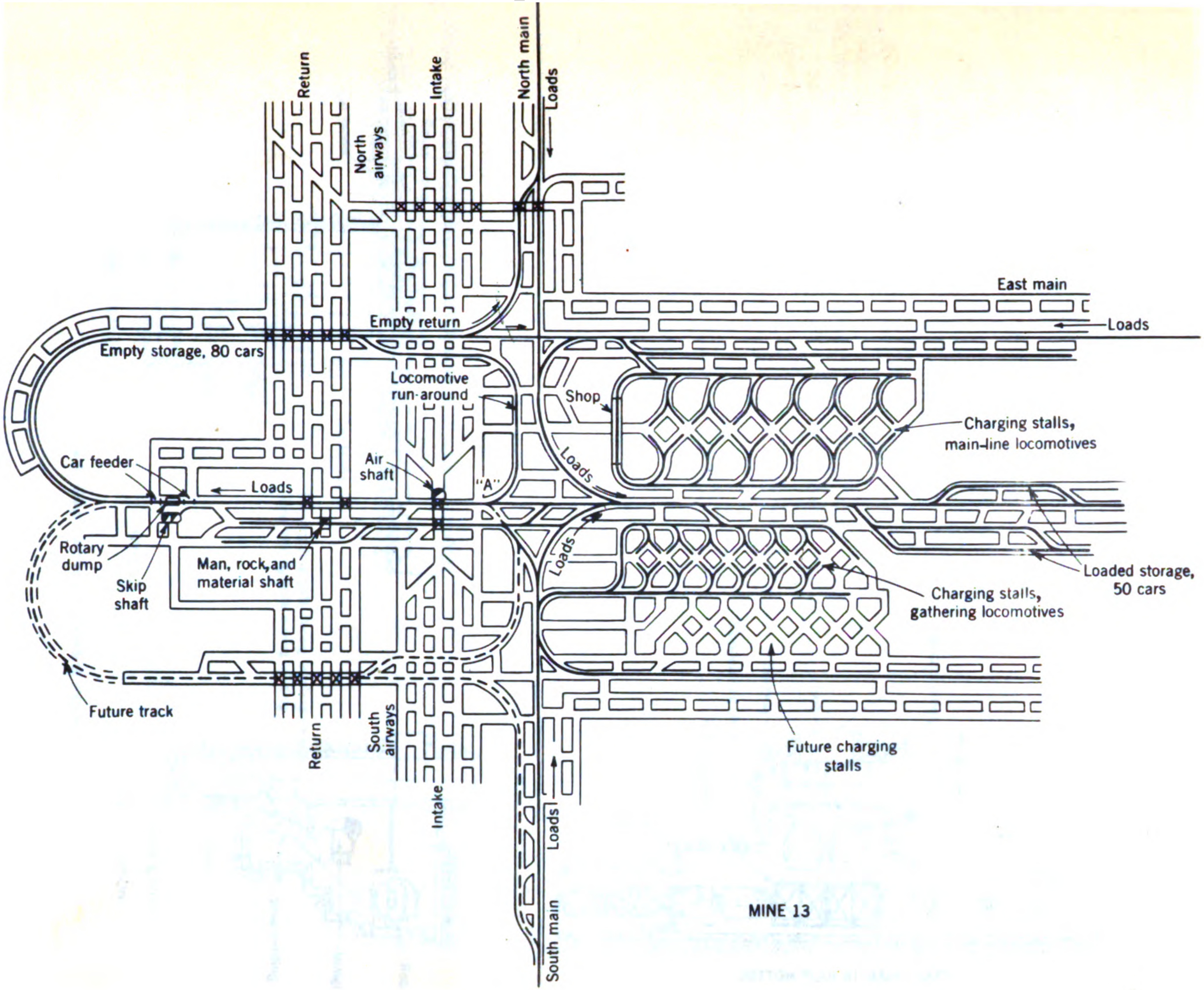


Figure 8.—Shaft-bottom lay-out, showing arrangement of tracks.

Original from THE OHIO STATE UNIVERSITY

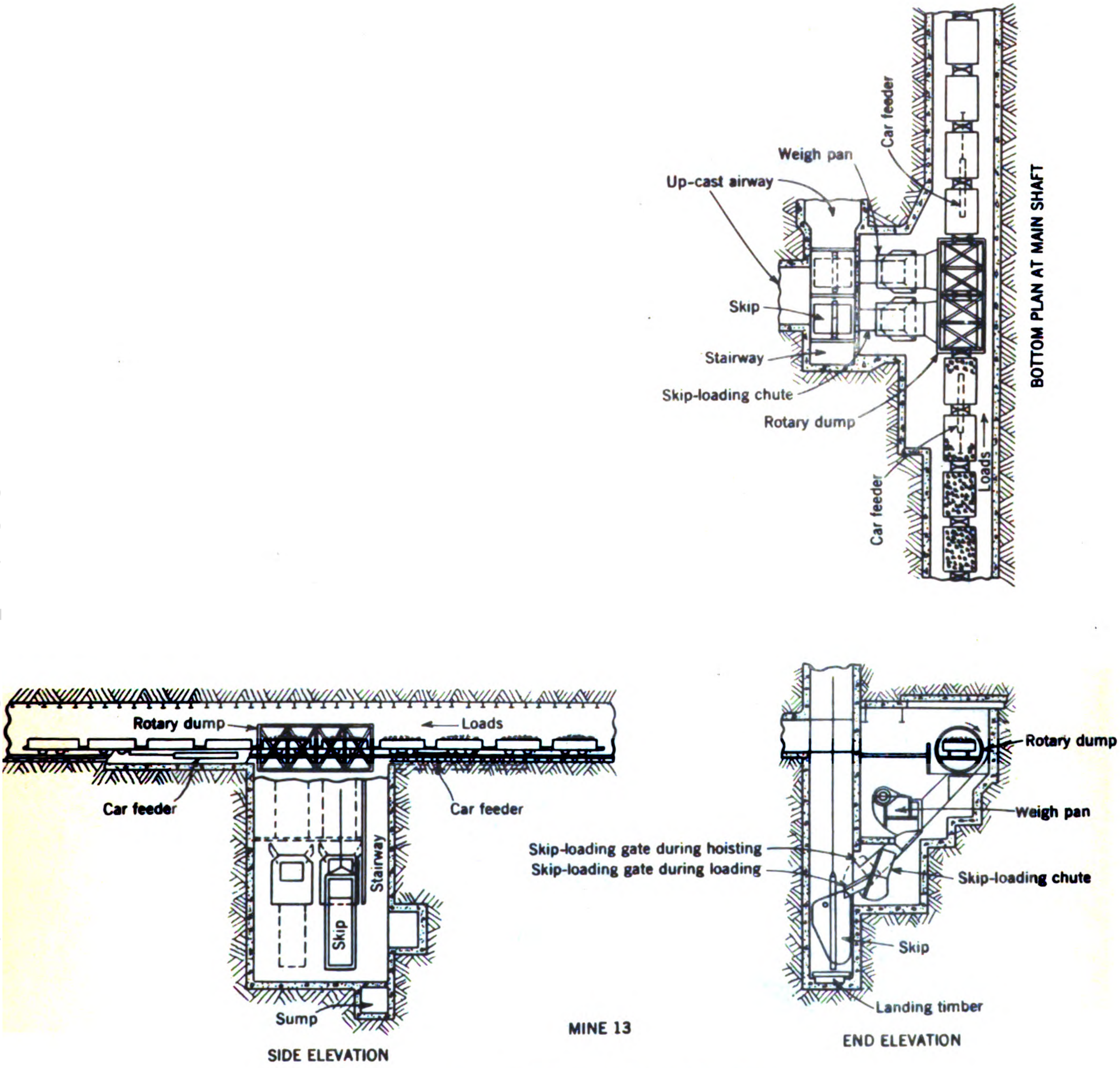
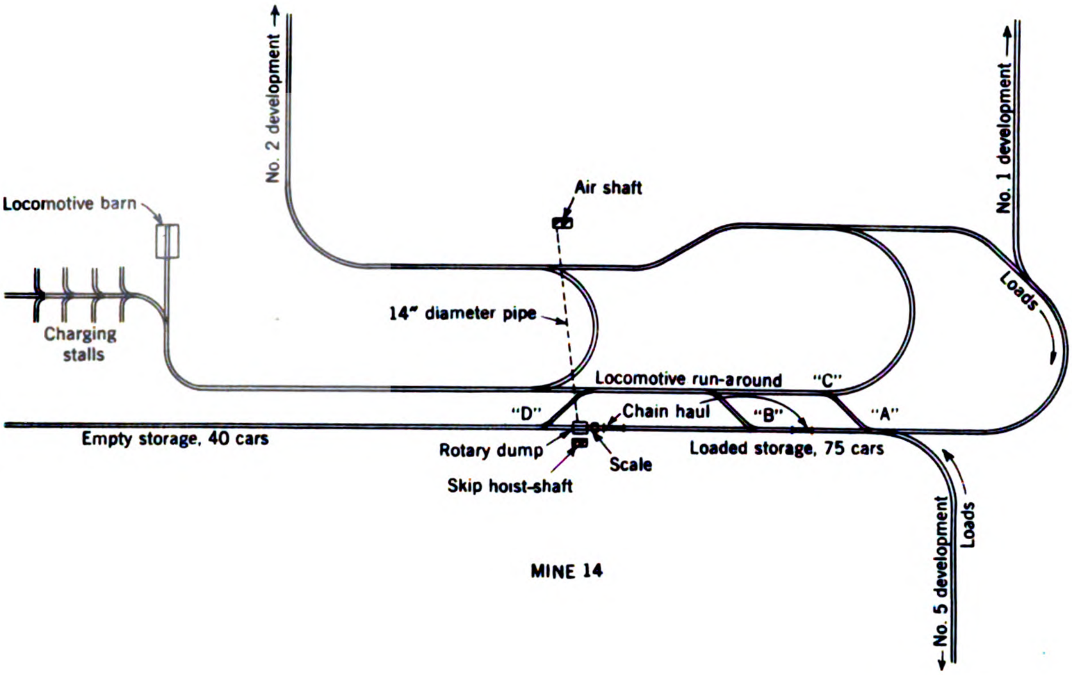
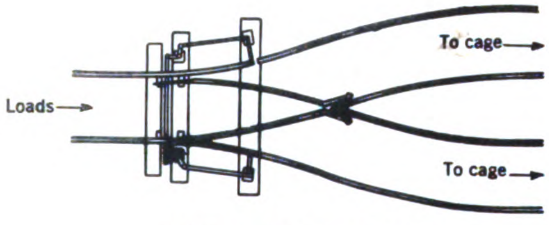


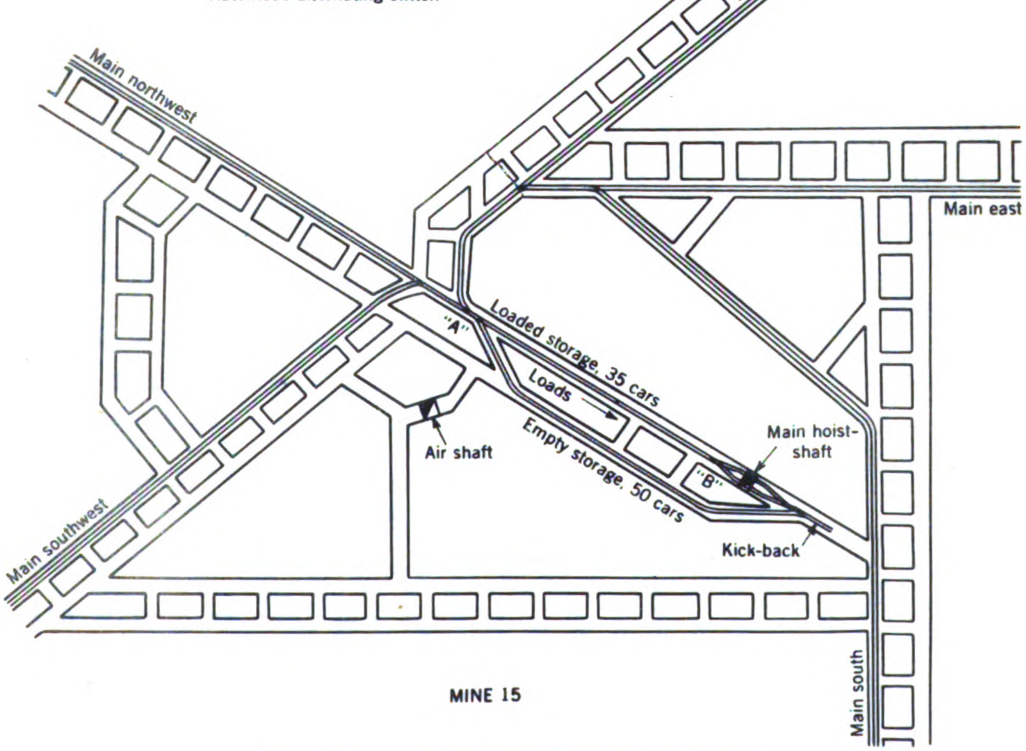
Figure 9.–Sketch showing skip-loading station.



MINE 14



Automatic alternating switch



MINE 15

Figure 10.—Sketch showing arrangement of tracks at shaft bottom.

the bottom by track cutting-machines. Power is supplied by battery power tanks (storage batteries mounted on a truck). Battery locomotives are used for both gathering and main-line haulage.

Masonry walls of sandstone are being built around the shaft bottom to protect the entries. The material for building these walls is obtained from various places in the mine where it has fallen from the roof. Two stonemasons work full time, and they use practically all the rock that falls throughout the mine.

Loaded trips come onto the bottom from development areas 2 or 5. (Area 1 is not being worked at present.) (See fig. 10.) There is storage capacity for 40 loaded cars between point "A" and the dump, and 35 more loaded cars could be stored above point "A". The locomotive takes the run-around at "A" or "B" and picks up the empty trip and returns along route "D - C" to No. 2 development, or along "D - C - A" to No. 5 development. The loaded tracks are about 1 percent downgrade for a distance of 500 feet above the first chain haul and approximately level from there on to the end of the empty storage tracks. The coal is weighed as the cars approach the dump. The empty coupler calls check numbers into a microphone and a loudspeaker announces them in the scalehouse.

Cars are dumped without being uncoupled, the rotary dump making a complete revolution. The dump is covered with a hood, from which a 14-inch pipe is connected to the upcast airshaft. This pipe discharges a large percentage of the fine dust caused by dumping. Coal passes from the rotary dump into a bin, which is filled only as the coal is drawn off. This bin is equipped with doors that are opened or closed automatically by either skip as they land or are pulled away. Two men handle both the loaded and empty cars on the bottom. One man operates the chain hauls and the dump and the other makes up empty trips. Dumping operations are stopped when a locomotive comes on the empty storage track for a trip of cars.

Summary, Mine 14

Coal hoisted per shift	cars,	400 (1,600 tons)
Rock hoisted per shift	do	10
Number of bottom employees handling coal		2
Coal per shift per bottom employee handling coal	tons,	800
Coal per shift per bottom employee handling coal, rock, and materials .	do	800
Average mine-car turn-over		0.91
Average number of cars per trip		30
Average track grade against loads		Approximately level

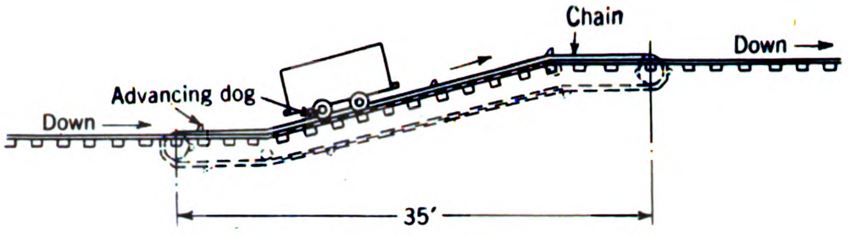
Mine 15

This mine was opened about 10 years ago. The shaft is near the center of the coal area to be mined, and main entries are driven in six directions. (See fig. 10.)

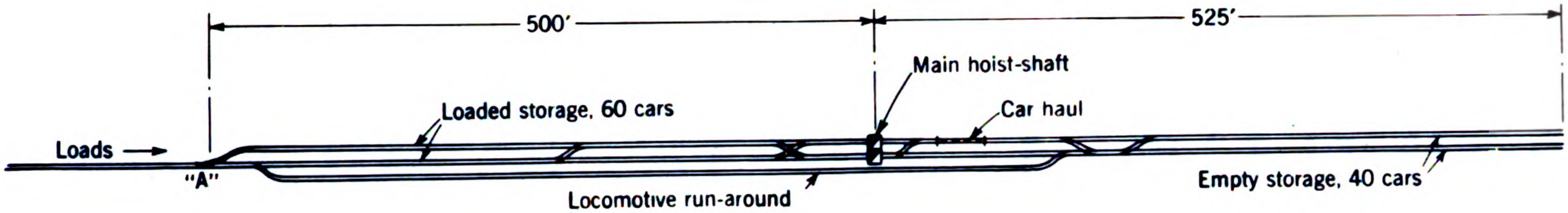
Room-and-pillar system of mining is used, with rooms driven on 33-foot centers, 24 feet wide and 150 feet long. Pick-mining and hand-loading are employed throughout the mine. The average production is 1,220 tons per shift. Mules are used for gathering the cars from the room necks to the partings. Entries are top-brushed, 6 feet wide.

Loaded trips are pulled onto the bottom to point "A", and the locomotive uncouples and takes the switch to the empty storage track. The loaded cars usually run by gravity from this point to the shaft, but if they stop they are "side-hooked" until they are all on straight track. This is accomplished by hooking a chain from the locomotive to an eye on the side of a car several car lengths back of point "A", and the trip is advanced by the locomotive running along the empty storage track. The dropper handles the loaded cars until they have advanced to the preceding trip, where the spragger takes them, and they are uncoupled and advanced to point "B". The two cagers take the cars after they have passed over the automatic alternating switch and cage them by hand. This automatic alternating switch is operated by the car wheels passing over levers on the track so that a car passing on the left track throws the switch for the next car to pass on the right side, and the motion is reversed by the following car. (See fig. 10.) The motion of the levers is transmitted to the switch points by means of rockers and connecting rods. There is an automatic latch on the cages that grips the axle of the cars, holding them in place while they are hoisted or lowered. The maximum speed of caging and hoisting is 270 cars per hour. Empty cars, on being pushed off the cage by the oncoming loaded car, run by gravity to a kick-back and return to the empty storage track. The loaded storage track is 1½ percent downgrade from point "A" to the frog, and 2 percent down from the frog to the shaft, a distance of 50 feet. The empty tracks are 6 percent downgrade from the shaft, a distance of 40 feet, then approximately level for 20 feet, then upgrade 11 percent for 15 feet, and 16 percent for 5 feet to the end of the kick-back. The empty storage track is downgrade 1½ percent from the frog at the kick-back, a distance of 150 feet.

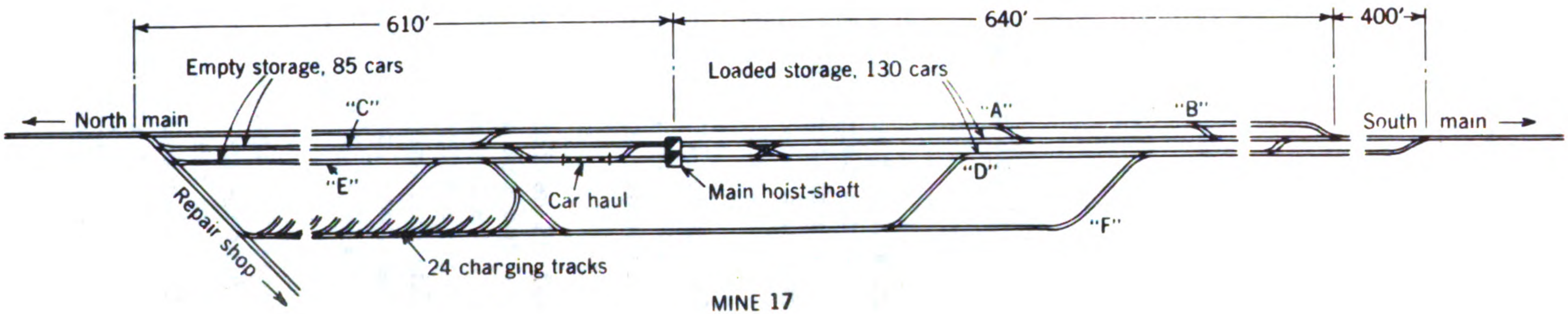
Original from THE OHIO STATE UNIVERSITY



Car haul



MINE 16



MINE 17

Figure 11.—Sketch showing arrangement of tracks at shaft bottom.

Summary, Mine 15

Coal hoisted per shift	cars,	1,375 (1,220 tons)
Rock hoisted per shift	do	150
Number of bottom employees handling coal		5
Coal per shift per bottom employee handling coal	tons,	244
Coal per shift per bottom employee handling coal, rock, and materials	do	244
Average mine-car turn-over		2.85
Average number of cars per trip		25
Average track grade against loads		Approximately level

Mine 16

This mine was opened a few years after the close of the Civil War. It was shut down several years ago, and the bottom was flooded for a few years. Recently, it was pumped out and reopened, and the bottom was reconstructed, concrete and stone being used for the walls and steel supports for the roof. Average production per shift is 1,500 tons.

Storage-battery locomotives are used for gathering. Charging stalls for the battery locomotives are situated near the partings, more than a mile from the shaft bottom. Rail joints on the main haulage track are welded.

Room-and-pillar system of mining is used. Rooms are driven 24 feet wide on 52- or 60-foot centers, and 390 feet long. Pillars are not recovered. Cutting is done by machines, and loading machines that operate on crawlers are used for loading. Each loading-machine crew consists of approximately 15 men, as follows: Cutting-machine man and helper, driller, shooter, two slate men, timberman, trackman, loading-machine operator and helper, clean-up man, motorman and trip rider, repairman, and one-third of a swing-motor crew of two men.

All loaded trips come onto the bottom from one direction and stop at point "A", where the locomotive uncouples and takes the run-around to the empty storage tracks. (See fig. 11.) The loaded cars run by gravity along the loaded storage tracks to the automatic cagers. One man handles all the cars on the loaded side of the shaft. As the empty cars are pushed off the cages, they run by gravity onto the car haul, which elevates them about 5 feet so that they may continue by gravity to the empty storage tracks.

Summary, Mine 16

Coal hoisted per shift	cars,	600 (1,500 tons)
Rock hoisted per shift	do	4
Number of bottom employees handling coal		3
Coal per shift per bottom employee handling coal	tons,	500
Coal per shift per bottom employee handling coal, rock, and materials	do	(1/)
Average mine-car turn-over		1.92
Average number of cars per trip		40
Average track grade against loads	percent,	Minus 1.5

1/ Not available. Rock is hoisted at night shift or on idle day.

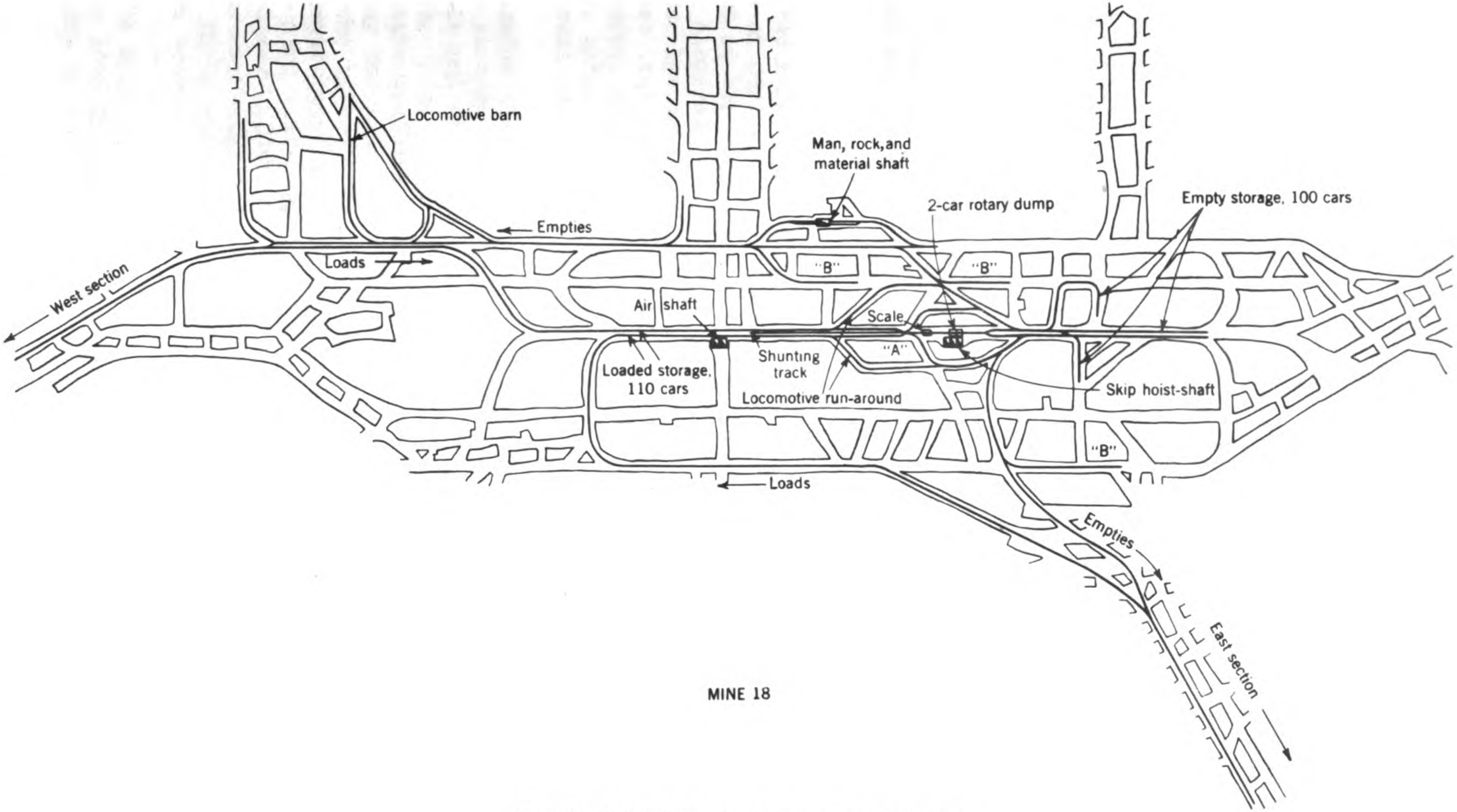
Mine 17

This mine has been operating a number of years, but the present bottom arrangement was installed recently. Room-and-pillar system of mining is used, with rooms 33 feet wide on 80-foot centers and 390 feet long. Pillars are not recovered. Coal is cut by machines and loaded with mobile loaders similar to mine 16. The loading crews consist of 16 men. The average production of the mine per shift is 3,800 tons.

Coal is gathered with storage-battery locomotives. Charging stalls consisting of 24 tracks are provided at the shaft bottom. (See fig. 11.)

Loaded trips come onto the bottom from opposite directions. The loads from the north pass the shaft and pull over onto the loaded storage track at "A". The locomotive uncouples and returns along "B" and picks up empty trip from track "C". Loaded trips from the south pull down to "D", uncouple, take the run-around and pick up empty trip from track "E", and return along "F". The loaded cars run by gravity to the shaft from the place where they are left by the locomotive, the movement being controlled by two droppers. One man handles the caging by means of automatic cagers. As the empty cars come off the cages they run by gravity onto the car haul, which elevates them about 5 feet, and they continue by gravity to the empty storage tracks.

A bottom crew of two motormen and one cager handles the rock on idle days.



MINE 18

Figure 12.—Shaft-bottom lay-out, showing arrangement of tracks.

Summary, Mine 17

Coal hoisted per shift	cars,	1,267 (3,800 tons)
Rock hoisted per shift	do	50
Number of bottom employees handling coal		5
Coal per shift per bottom employee handling coal	tons,	760
Coal per shift per bottom employee handling coal, rock, and materials	do	(1/)
Average mine-car turn-over		2.15
Average number of cars per trip		40
Average track grade against loads		Approximately level

1/ Not available. Rock is hoisted at night shift or on idle day.

Mine 18

This mine has been in operation a number of years. Room-and-pillar system of mining is used, with rooms 26 feet wide on 50-foot centers and 300 to 400 feet long. The average production per shift is 7,000 tons. Mining machines are used for cutting, and mobile loading machines are used for loading. One loading-machine crew consists of 14 men, as follows: two cutting-machine men, two drillers, shot-firer, timberman, tracklayer, tracklayer's helper, loading-machine runner, loading-machine helper, clean-up man, two motormen and trip rider. Coal is gathered by cable-reel and battery locomotives.

Loaded trips from the east or west section of the mine pull onto the loaded storage tracks to the locomotive run-arounds, where the locomotives uncouple and proceed to the empty storage tracks for the return trip of empties. (See fig. 12.) The loaded cars are advanced by a shunting locomotive operating on a track between the two loaded tracks. This shunting locomotive has a sliding arm that is extended either to the right or to the left and engages a mine car and advances the trip to point "A". The loaded cars run by gravity from this point over the scale and onto the rotary dump, where two cars are dumped at one operation. The cars are weighed and dumped without uncoupling. A brake called a "squeezer", which is four car-lengths above the dump, is used to feed the cars onto the dump. Empty cars run by gravity from the rotary dump onto the empty storage tracks.

The coal is dumped into a hopper equipped with automatic chutes for loading into the skips. As a skip descends, the chute that feeds into that skip is lowered with the skip, and when the skip ascends the chute is raised. The skips have a capacity of 10 tons, or two cars, of coal. Cars of rock take the run-arounds at "A" and are switched to storage tracks "B", to be hoisted at the man, rock, and material shaft on an idle day or the night shift.

The helper on the shunting locomotive is listed under the "General" heading on the table "Number of bottom employees handling coal."

Summary, Mine 18

Coal hoisted per shift	cars,	1,650 (7,000 tons)
Rock hoisted per shift	do	14 [1]
Number of bottom employees handling coal		5
Coal per shift per bottom employee handling coal	tons,	1,400
Coal per shift per bottom employee handling coal, rock, and materials	do	([2])
Average mine-car turn-over		2.22
Average number of cars per trip		30
Average track grade against loads	Approximately level	

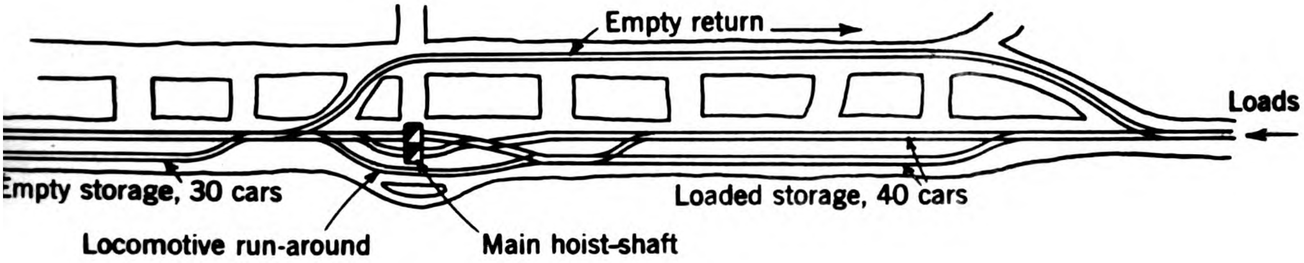
---

[1] Hold for night shift or idle day.
[2] Not available. Rock is hoisted at night shift or on an idle day.

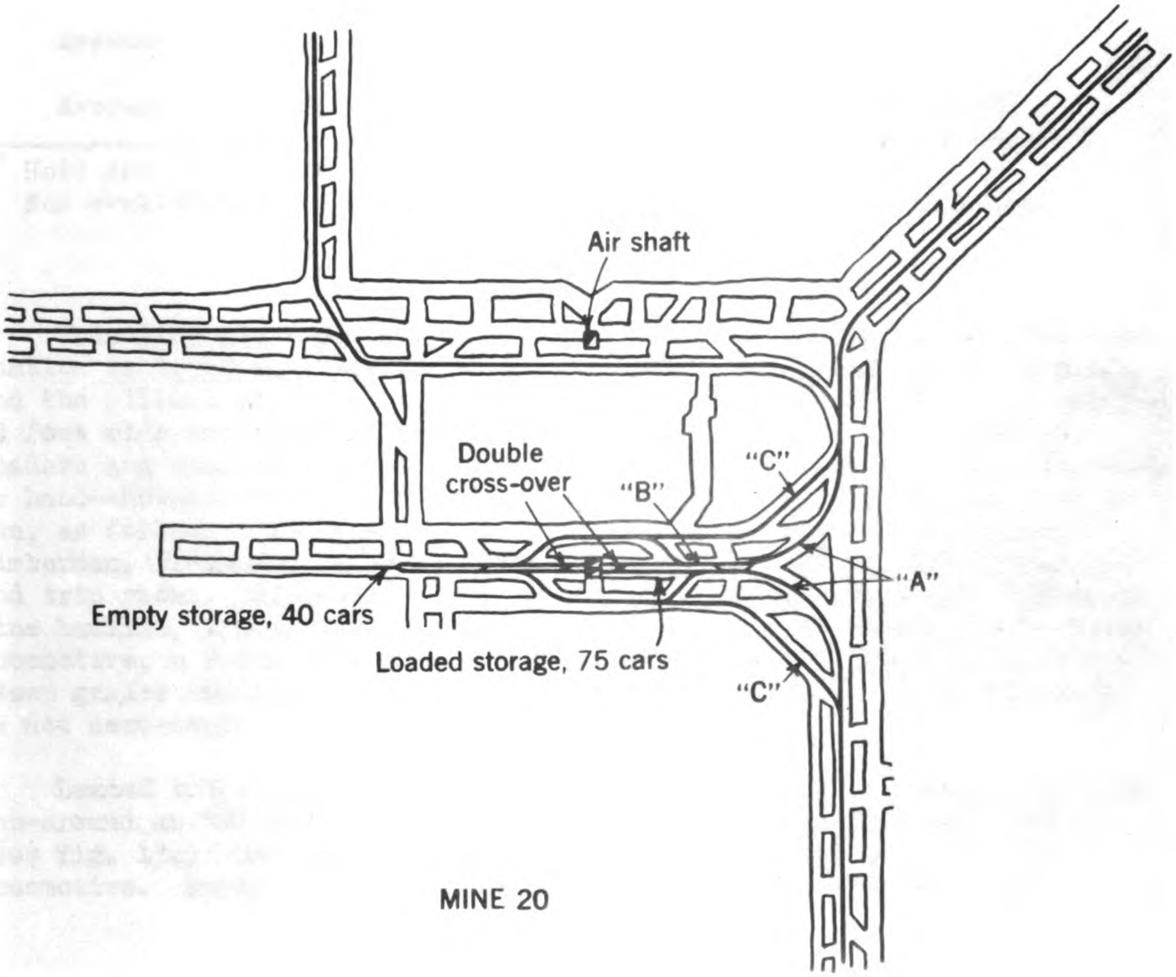
Mine 19

This mine has been in operation about 20 years. Room-and-pillar mining system is used, and the pillars are not recovered. Rooms are driven on 50-foot centers, 28 feet wide and 260 feet long. Machines are used for cutting, and all coal is loaded by hand. Average production per shift is 2,200 tons. Coal is gathered by mules, cable-reel locomotives, and battery locomotives.

Track arrangement on bottom is shown in figure 13. The locomotive advances the trip of loaded cars to the run-around. Two spraggers advance the loads to the cagers, where they are caged by hand. Empty cars run by gravity to the empty storage tracks.



MINE 19



MINE 20

Figure 13.–Shaft-bottom lay-out, showing arrangement of tracks.

Summary, Mine 19

Coal hoisted per shift	cars,	1,190 (2,200 tons)
Rock hoisted per shift	do	40[1]
Number of bottom employees handling coal		6
Coal per shift per bottom employee handling coal	tons,	367
Coal per shift per bottom employee handling coal, rock, and materials	do	([2])
Average mine-car turn-over		3.73
Average number of cars per trip		23
Average track grade against loads	percent,	Minus 3.5

---

[1] Hold for night shift or idle day.
[2] Not available. Rock is hoisted at hight shift or on idle day.

Mine 20

This mine has been in operation for a number of years. Average production is 1,400 tons per shift. Room-and-pillar mining system is used, and the pillars are not recovered. Rooms are driven 400 feet long and 33 feet wide on 53-foot centers. Coal is cut by machines, and mobile loaders are used throughout, except in one pair of entries, where the coal is hand-shoveled onto a conveyor. A loading-machine crew consists of 10 men, as follows: Cutting-machine man and helper, driller and helper, timberman, trackman, loading-machine operator and helper, and a motorman and trip rider. Cable-reel locomotives are used for gathering. On main-line haulage, a motorman is employed instead of a trip rider. This extra locomotive, a 7-ton unit, follows the trips and helps the loads over the steep grades and pushes empty cars in sidings, so that flying switching is not necessary.

Loaded trips come onto the bottom over track "A", uncouple, and take run-around at "B" and pick up empty trip, and return along track "C". (See fig. 13.) The loaded cars are advanced to the cager by a 7-ton locomotive. Empty cars run by gravity onto the empty storage track.

Summary, Mine 20

Coal hoisted per shift	cars,	430 (1,400 tons)
Rock hoisted per shift		None
Number of bottom employees handling coal		3
Coal per shift per bottom employee handling coal	tons,	467
Coal per shift per bottom employee handling coal, rock, and materials	do	467
Average mine-car turn-over		2.26
Average number of cars per trip		26
Average track grade against loads	percent,	Minus 0.5

Mine 21

This mine is 100 percent mechanized. It began operations about 4 years ago. The average production per shift is 1,800 tons. Room-and-pillar system of mining is employed, with rooms driven 20 feet wide, on 28-foot centers, and 350 feet long. Track-mounted cutting and loading machines are used, and a complete crew usually consists of approximately 20 men, classified as follows: 5 track-layers, 3 timbermen, cutting-machine man and helper, mucker (shovels machine cuttings), 2 drillers, loading-machine operator, 2 loading-machine helpers, 2 motormen, trip rider, boss, and one-half time of 1 electrician. Cable-reel locomotives are used for gathering. There are no regular partings. Loaded trips are made up approximately 150 feet from the loading face, so that car changes can be made quickly. These gathering places are in an adjacent room or along the entries and they move up as rooms advance.

The bottom arrangement consists of a single track over a two-compartment bin. Mine cars have drop bottoms, which automatically open as the cars pass over the bins and close as the cars pass off the bins. The trips of cars are not turned around but are pushed back to the gathering places. The bin has a capacity of 125 tons, or 30 cars. Coal is fed from the bin onto a chain-and-flight conveyor. This conveyor is 4 feet wide and operates on a 34° slope with a maximum capacity of 375 tons per hour.

Summary, Mine 21

Coal hoisted per shift	cars,	425 (1,800 tons)
Rock hoisted per shift		None
Number of bottom employees handling coal		None
Coal per shift per bottom employee handling coal	tons,	---
Coal per shift per bottom employee handling coal, rock, and materials	do	---
Average mine-car turn-over		4.09
Average number of cars per trip		11
Average track grade against loads		Approximately level

SPECIAL FEATURES

An Underground Broadcasting Station

At the shaft bottom of one of the mines discussed in this paper, a broadcasting station has been installed. It is operated 15 to 20 minutes at the beginning of the shift for the benefit of the miners who are waiting for the man-trip. Safety talks, which are never more than 5 minutes in length, are always a part of the program, and they are usually preceded by music from phonograph records.

The broadcasting unit is in the mine manager's office, and five dynamic speakers are located along the entry where the man-trips are made up. The sound is effective along the entry for a distance of 550 feet without distortion. The set is similar to a public-address system, and the sound is transmitted from the amplifier to the speakers by wires. The farthest speaker is 800 feet from the broadcasting unit. Electric power at 110 volts alternating current is used to operate the set.

Total cost of installation, which includes 35-watt amplifier, microphone, phonograph, five dynamic loud-speakers, monitor speaker, and cables, was approximately $500.

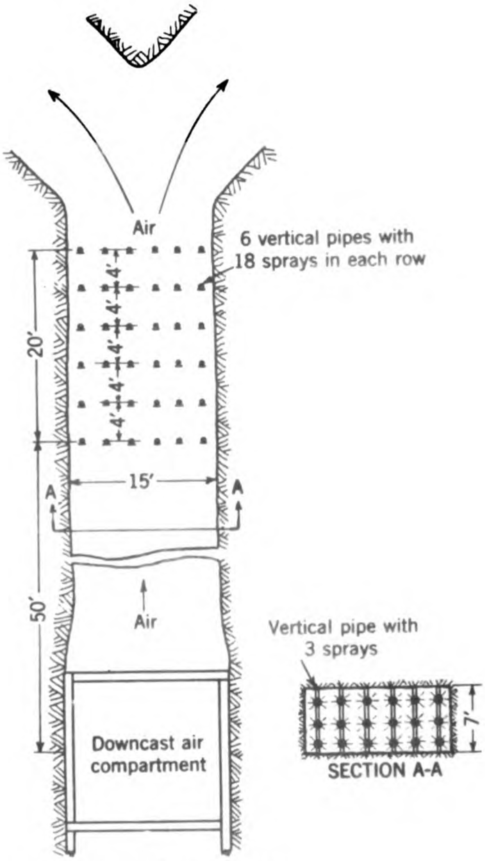
Air-Cooling Plant

An air-cooling plant has been installed on the shaft bottom of one of the mines discussed in this paper. The purpose of the plant is to cool the intake air during the hot summer months to prevent falls of roof rock.

This cooling plant is 50 feet from the bottom of the air shaft, and all the air entering the mine (about 70,000 cubic feet per minute) passes through it. (See fig. 14.) It consists of six sets of 18 water sprays. The sprays issue a fine sheet of water at right angles to the flow of air. A recirculation pump forces 324 gallons of mine water per minute through the system at a pressure of 25 pounds per square inch. Each spray requires 3 gallons of water per minute. The temperature of the mine water that is drained from sealed workings varies from 56° to 60° F., and the temperature of the air after cooling ranges from 60° to 64° F. The cooling system is in operation about 7 months of the year.

Although the cooled air has a high relative humidity, it contains less moisture by weight than the warm air entering the mine. This cooling of air has little or no effect on the miner, since the seasonal temperature change in a mine 1,000 feet or more from the opening is only a few degrees.

Two theories are given to explain the deterioration of the mine roof during the summer: one is that the excess moisture in the warm air acts on the lime (CaO) or some other ingredient of the roof and causes it to


Air
6 vertical pipes with 18 sprays in each row
20'
4'
4'
4'
4'
4'
15'
A
A
50'
Air
Downcast air compartment
Vertical pipe with 3 sprays
7'
SECTION A-A

Arrangement of water sprays for cooling intake air

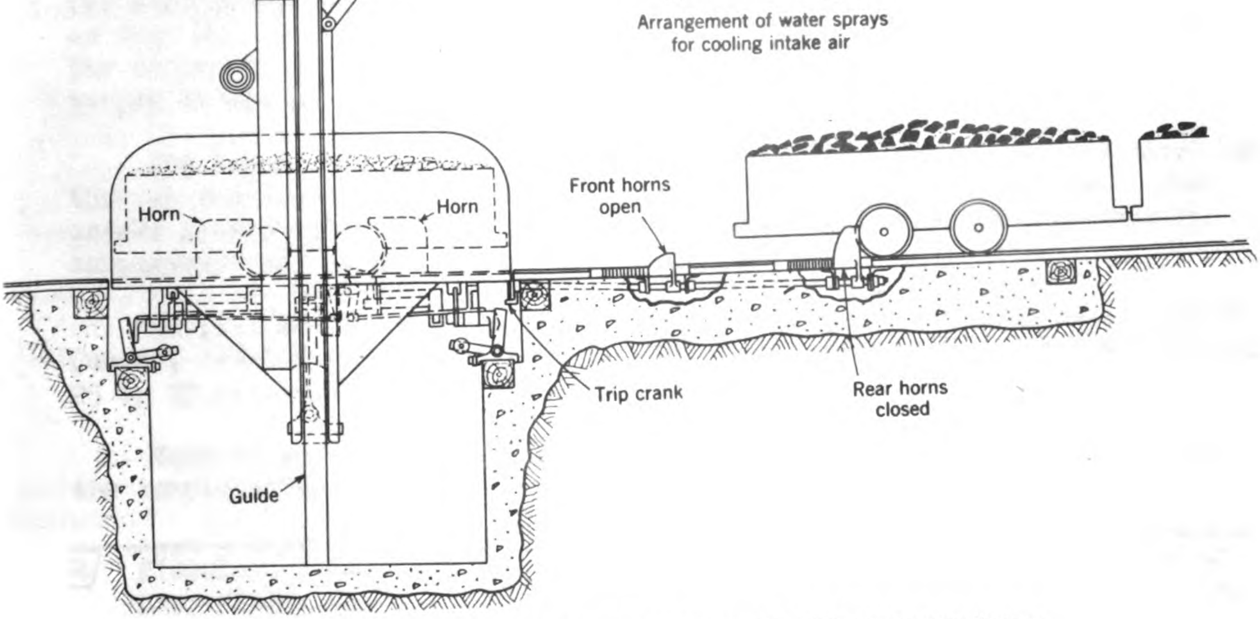


Figure 14.–Sketch showing an automatic double-horn cager and a self-dumping automatic cage.

crack and fall; another is that seasonal changes and warm air during the day and cool air at night cause the roof to expand and contract alternately, and therefore loosen and fall. Probably the heat and cold have more effect than the moisture in causing the rock falls. Observations made at another mine in this same district [4] led to the above assumption, as it was noticed that fresh falls never had any perceptible moisture along the bedding planes where they broke away from the roof.

Total cost of above described plant was approximately $2,500. The monthly cost of operation is $50.

Air-Heating Plant

One of the mines included in this paper has installed an air-heating plant to prevent the formation of ice on the walls of the intake airshafts. Since this heating system has been in operation (during the winters of 1934-35 and 1935-36), there have been no idle days due to formation of ice in the shafts. Surface temperatures as low as minus 12° F. were recorded at this mine during the winter of 1935-36, and the low temperature on the shaft bottom was 35° F.

The heating plant consists of three 150-horsepower boilers, which supply steam to radiators built in the side walls of structures surrounding the shafts. There are 18 radiator units, each being about 30 inches wide and 10 feet high and containing 190 sq. ft. of heating surface. The main hoist-shaft has 11 radiator units and the man and supply shaft has 7. The steel buildings containing these radiators have the walls extended a few feet above the radiators, but the buildings are only partly covered, so that all the intake air does not have to pass through the radiators. The condensed steam from the radiators is caught in drain traps and returned to the boilers.

The total ventilating current, 265,000 cu.ft. per minute, is exhausted through the upcast compartment of the air shaft by an exhaust fan. The intake flow of air is down the main hoist-shaft and the man and supply compartment of the air shaft.

Total cost of heating plant was $30,000, which includes boiler plant (used), steam pipe and fittings, 18 radiator units, and 2 steel buildings, 25 by 29 feet and 16 by 19 feet, respectively.

Monthly cost of operation ranges from $750 to $1,000, depending on the temperature.

---

[4] Fletcher, J. H., and Cassidy, S. M., Air Cooling to Prevent Falls of Roof Rock: Am. Inst. Min. and Mech. Eng. Tech. Pub. 387, 1931, p. 4.

Digitized by Google Original from THE OHIO STATE UNIVERSITY

EXPLANATION OF TABLES

Shaft- and Slope-Bottom General Data

Table 1 shows the general data on the 21 shaft and slope bottoms. The shafts vary from 110 to 600 feet in depth, and the minimum and maximum slope lengths are 100 and 580 feet, respectively.

Generally, the capacity for empty-car storage is less than that for loaded cars. Average storage capacity of the 20 mines using storage is 104 loaded cars and 79 empty cars. Each mine has storage capacity for both loaded and empty cars greater than the size of the largest main-line trip. The amount of rock handled by each mine varies from none to 200 cars per shift. Eleven mines use the same hoist for both coal and rock, seven use a separate shaft or slope, and three do not hoist rock.

Number of Bottom Employees Handling Coal

Table 2 shows the number of bottom employees, classified according to their various duties. Car greasers, weighmen, and dispatchers are not included with bottom men handling coal. Average number of bottom employees at the 20 mines employing bottom men is 3.0 men handling loaded cars and 1.5 men handling empty cars.

Labor Data on Bottom Employees

Table 3, which shows the labor data on the bottom employees, is based on a 7-hour hoist shift. The extra time necessary at some of the mines for caging men before and after the shift is not included, as some of the other mines have auxiliary shafts or slopes for handling men. The following is a summary of bottom labor performance according to the type of hoisting:

Type of hoisting	Number of mines	Average cost, man-hour per ton	Tons per shift per bottom employee
Cage (hand caging).....	4	0.021	329
Cage (automatic caging)	10	.014	490
Skip..................	4	.006	1,180
Conveyor...............	3	.010	675
Conveyor[1].............	2	.016	450
Average............	21	.012	580

[1] Omitting the slope mine, where no bottom labor is required.

Original from THE OHIO STATE UNIVERSITY

Mine-Car Data

Table 4 shows the number, type, and size of mine cars in use at the mines visited. Average mine-car turn-over is the total number of cars of coal and rock dumped per shift divided by the total number of cars in use. Mine 21, using the automatic drop-bottom cars with no storage of cars on the bottom, has the maximum mine-car turn-over, 4.09, and the minimum of 0.91 is at mine 14, where battery locomotives are used for main-line haulage.

Main-Haulage Data

Table 5 is main-haulage data, which includes track gage, number and type of locomotives, length of haul, cars per trip, and number of partings served. The weight of rail and the maximum and average grade of track against the loads is also shown. There are six different track gages in use; the minimum is 36 inches and the maximum is 52 inches. The minimum and maximum main-line haulage is 0.5 and 4.0 miles, respectively.

Car-Loading Data

Table 6 shows the number of loaders, tons per loader, cars in use per loader, and average thickness of coal mined. The number of loaders includes all men on loading crews where mechanical loading is employed. Tons per loader per shift range from 3.5 to 27.8. Because of different physical conditions at the various mines, labor data are not strictly comparable. Average capacity of car in use per loader is the total number of cars in use times the car capacity in tons, divided by the number of loaders.

Original from THE OHIO STATE UNIVERSITY

TABLE 1. - Shaft- and slope-bottom general data

Mine no.	State	Shaft depth, feet	Slope length, feet, and angle	Bottom roof support	Coal hoisting type and capacity	Coal hoisted per shift		Bottom storage capacity	
						Cars	Tons	Loads	Empties
1..	Pa.	250	-	Concrete.	Skip, 15 tons.	1,555	5,600	300	200
2..	do	350	-	Concrete and steel.	Automatic cage, 1-car.	900	2,700	198	98
3..	do	165	-	Steel on brick pillars.	do	720	1,950	59	60
4..	do	285	-	None.	do	300	600	49	139
5..	do	325	-	Masonry, steel, and concrete.	do	750	1,500	80	73
6..	do	270	-	Steel.	do	1,030	3,100	88	60
7..	do	440	-	Brick and steel.	Automatic cage, 2 cars in tandem.	1,000	3,000	180	80
8..	W. Va.	440	-	None.	Automatic cage, 1-car.	650	1,950	97	86
9..	do	305	-	Timber, masonry and steel.	do	750	3,400	134	93
10..	do	200	-	None.	do	390	1,050	33	66
11..	do	-	580 - 19°	None.	48-inch belt conveyor.	485	1,700	80	80
12..	do	-	290 - 18°	Steel.	42-inch belt conveyor.	730	1,900	230	80
13..	do	585	-	do.	Skip, 15 tons.	700	3,500	50	80
14..	do	600	-	Masonry walls.	Skip, 11 tons.	400	1,600	75	40
15..	Kan.	110	-	Concrete and steel.	Automatic cage, 1 car.	1,375	1,220	35	50
16..	Ill.	365	-	Concrete, stone, and steel.	do	600	1,500	44	40
17..	do	375	-	Concrete.	do	1,267	3,800	130	85
18..	do	425	-	Concrete and steel.	Skip, 10 tons.	1,650	7,000	110	100
19..	do	420	-	Timber and steel.	Automatic cage, 1 car.	1,190	2,200	40	30
20..	Ind.	218	-	None.	do	430	1,400	75	40
21..	do	-	100 - 34°	Timber.	48-inch chain and flight conveyor.	425	1,800	0	0

TABLE 1. - Shaft- and slope-bottom general data (cont'd)

Mine no.	Method of handling cars			Rock-hoisting type	Rock cars per shift	Cars of coal per car of rock
	Loads	Caging	Empties			
1..	Locomotive and chain haul.	Rotary dump.	Locomotive.	Slope rope haul.	200	7.8
2..	Gravity.	Automatic.	Gravity.	Separate shaft.	200	4.5
3..	do.	do.	do.	Same as coal.	60	12.0
4..	do.	do.	do.	do.	45	6.7
5..	do.	do.	do.	do.	60	12.5
6..	Locomotive.	Hand.	Locomotive.	do.	120	8.6
7..	Gravity.	Automatic.	Gravity.	Separate shaft.	170	5.9
8..	do.	do.	do.	Same as coal.	[1]125	5.2
9..	Chain haul.	do.	Locomotive.	Separate shaft.	78	9.6
10..	Gravity.	Hand.	Car-lift.	-	None.	-
11..	Chain haul.	Rotary dump.	Gravity.	Same as coal.	73	6.6
12..	do.	Cross-over dump.	do.	Separate slope.	63	11.6
13..	Car feeder.	Rotary dump.	Car feeder.	Separate shaft.	100	7.0
14..	Chain haul.	do.	Chain haul.	Same as coal.	10	40.0
15..	Gravity.	Hand.	Gravity.	do.	150	9.2
16..	do.	Automatic.	Chain haul.	do.	4	150.0
17..	do.	do.	do.	do.	50	25.3
18..	Locomotive.	Rotary dump.	Gravity.	Separate shaft.	[1]14	117.8
19..	Gravity.	Hand.	do.	Same as coal.	[1]40	29.7
20..	Locomotive.	Automatic.	do.	-	None.	-
21..	do.	Automatic drop-bottom cars.	Locomotive.	-	None.	-

---

[1] Hold for night shift or idle day.

TABLE 2. - Number of bottom employees handling coal

Mine no.	Motormen		Couplers or snappers		Droppers and spraggers		Dumpers, loads	Cagers, loads	General		Total		Grand total
	Loads	Empties	Loads	Empties	Loads	Empties			Loads	Empties	Loads	Empties	
1	1	1	1	1	-	-	1	-	-	-	3	2	5
2	-	-	-	2	2	-	-	1	-	-	3	2	5
3	-	-	1	1	1	-	-	1	-	-	3	1	4
4	-	-	-	1	-	-	-	1	-	-	1	1	2
5	-	-	-	1	2	-	-	1	-	-	3	1	4
6	1	1	-	-	3	1	-	1	-	-	5	2	7
7	-	-	-	2	4	-	-	1	-	-	5	2	7
8	-	-	-	1	1	1	-	1	-	-	2	2	4
9	-	1	-	1	2	-	-	2	1	0.5	5	2.5	7.5
10	-	1	-	1	2	-	-	1	-	-	3	2	5
11	-	-	-	-	1	-	1	-	-	1	2	1	3
12	-	-	1	1	1	-	2	-	-	-	4	1	5
13	-	-	-	-	1	-	1	-	-	1	2	1	3
14	-	-	-	1	-	-	1	-	-	-	1	1	2
15	-	-	-	1	2	-	-	2	-	-	4	1	5
16	-	-	-	1	-	1	-	1	-	-	1	2	3
17	-	-	-	2	2	-	-	1	-	-	3	2	5
18	1	-	-	-	-	2	1	-	1	-	3	2	5
19	-	-	1	1	2	-	-	2	-	-	5	1	6
20	1	-	-	1	-	-	-	1	-	-	2	1	3
21	-	-	-	-	-	-	-	-	-	-	None.	None.	None.

TABLE 3. - Labor data on bottom employees

Mine no.	Number handling		Man-hour per ton of coal		Tons of coal per shift per employee	
	Rock and materials	Coal, rock, and materials	Handling coal	Handling coal, rock, and materials	Handling coal	Handling coal, rock, and materials
1	4	9	0.006	0.011	1,120	622
2	3	8	.013	.021	540	337
3	1/	4	.014	.014	487	487
4	None.	2	.023	.023	300	300
5	1/	4	.019	.019	375	375
6	1/	7	.016	.016	443	443
7	2	9	.016	.021	428	333
8	2/	2/	.014	2/	487	2/
9	1.5	9	.015	.019	453	378
10	None.	5	.033	.033	210	210
11	1/	3	.012	.012	566	566
12	None.	5	.018	.018	380	380
13	2	5	.006	.010	1,167	700
14	1/	2	.009	.009	800	800
15	1/	5	.029	.029	244	244
16	2/	2/	.014	2/	500	2/
17	2/	2/	.009	2/	760	2/
18	2/	2/	.005	2/	1,400	2/
19	2/	2/	.019	2/	367	2/
20	None.	3	.015	.015	467	467
21	None.	None.	None	None.	-	-

1/ Included with employees handling coal.
2/ Not available. Rock is hoisted at night shift or on idle day.

TABLE 4. - Mine-car data

Mine no.	Number in use	Type of cars	Bearings	Capacity, tons	Height above rail, inches	Overall length		Average turn-over
						Feet	Inches	
1	1,700	Steel, solid end.	Antifriction.	3.6	36	11	10	1.03
2	800	Steel, wooden bottom, end-dumping.	do.	3.0	44	10	0	1.37
3	444	Steel, wooden bottom, wooden end-dumping.	do.	2.7	45	9	6	1.76
4	175	Wooden, end-dumping.	Plain	2.0	46	9	6	1.97
5	617	do.	do.	2.0	41	9	6	1.31
6	750	Steel, wooden bottom, end-dumping.	do.	3.0	54	9	6	1.50
7	1,000	Steel, wooden bottom, solid end.	Antifriction.	3.0	43	9	0	1.17
8	525	Steel, end-dumping.	do.	3.0	28	12	0	1.47
9	500	do.	do.	4.5	30	13	0	1.65
10	300	Steel and wooden, end-dumping.	do.	2.7	27 and 37	10	6	1.30
11	195	Steel, solid end.	do.	3.5	24	12	3	2.87
12	400	Steel, end-dumping.	do.	2.6	24	12	0	1.98
13	611	Steel, solid end.	do.	5.0	36	12	0	1.31
14	450	do.	do.	4.0	32	12	4	.91
15	535	Wooden, end-dumping.	do.	.9	26	7	0	2.85
16	315	do.	do.	2.5	52	8	2	1.92
17	612	do.	do.	3.0	56	8	2	2.15
18	750	Steel, solid end.	do.	4.25	55	12	0	2.22
19	330	Wooden, end-dumping.	Plain.	1.85	34 and 46	9	0	3.73
20	190	Steel and wooden, end-dumping.	Antifriction.	3.25	48	9	0	2.26
21	104	Steel, drop-bottom.	do.	4.25	42	12	4	4.09
Average	538	-	-	3.08	-	-	-	1.94

TABLE 5. - Main-haulage data

Mine no.	Track gage, inches	Locomotives number and type	Average length of haul, miles	Number of		Track grade against loads		Weight of rails, lb.
				Cars per trip, average	Partings served	Maximum percent	Average percent	
1	44	8 - 13-ton, trolley.	3.0	40	10	2.0	Approx. level	70
2	44	4 - 15-ton, trolley.	1.5	42	6	3.5	1.7	60
3	44	2 - 13-ton, trolley.	2.0	36	17	2.0	.8	40 and 60
4	44	1 - 10-ton and 1 - 15-ton trolley.	1.5	27	2	3.0	1.0	40 and 60
5	42	3 - 13-ton and 2 - 15-ton trolley.	1.5	34	10	4.0	Approx. level	60
6	42	8 - 10-ton trolley.	3.0	50	4	1.5	do	60
7	48	3 - 10-ton and 3 - 13-ton trolley.	2.1	37	4	2.0	Minus 0.5	60
8	40	1 - 10-ton, 13-ton, and 15-ton trolley.	1.5	27	11	4.5	1.0	60
9	44	5 - 12 to 15-ton trolley.	3.0	40	12	3.0	Approx. level	60
10	52	1 - 13-ton and 1 - 15-ton trolley.	1.3	25	3	5.0	do	40
11	48	1 - 10-ton trolley.	.9	12	7	2.0	do	60
12	44	8 - 10-ton trolley.	4.0	22	9	5.0	4.0	60
13	48	3 - 20-ton battery.	1.6	45	6	3.0	Approx. level	60
14	48	6 - 13-ton battery.	1.3	30	4	6.0	do	60
15	42	2 - 8-ton and 1 - 7-ton trolley.	.5	25	8	3.0	do	30
16	42	2 - 13-ton trolley.	1.3	40	2	None.	Minus 1.5	40
17	42	3 - 13-ton trolley.	1.3	40	4	1.0	Approx. level	40
18	42	6 - 15-ton trolley.	2.0	30	5	2.0	do	60
19	36	3 - 10-ton and 1 - 7½-ton trolley.	1.0	23	4	None.	Minus 3.5	40
20	42	1 - 13-ton trolley.	1.5	26	2	2.5	Minus 0.5	40 and 60
21	42	1 - 12-ton and 1 - 13½-ton trolley.	.6	11	See text.	5.3	Approx. level	60
Average	-	-	1.73	31.5	-	-	-	-

TABLE 6. - Coal-loading data

Mine no.	Average daily production, tons	Average number of loaders per shift[1]	Average tons of coal per loader per shift[1]	Average number of cars in use per loader[1]	Average Car capacity in use per loader[1] tons	Average thickness Coal mined, inches	Average thickness Draw slate, inches
1	5,600	313	18.0	5.43	19.55	94	12
2	2,700	260	10.4	3.08	9.23	72	12
3	1,950	250	7.6	1.76	4.79	72	12
4	600	150	8.0	1.17	2.33	54	15
5	1,500	214	7.0	2.89	5.77	72	10
6	3,100	385	8.0	1.95	5.84	72	11
7	3,000	375	8.0	2.67	8.00	66	11
8	1,950	234	9.2	2.24	6.73	48	[2] 4
9	3,400	285	12.0	1.75	7.89	58	7
10	1,050	75	14.0	4.00	10.80	54	None.
11	1,700	130	13.0	1.50	5.25	30	None.
12	1,900	160	12.0	2.50	6.50	38	8
13	3,500	270	13.0	2.26	11.31	80	None.
14	1,600	120	13.5	3.75	15.00	68	None.
15	1,220	375	3.5	1.43	1.28	38	4
16[3]	1,500	90	16.7	3.50	8.74	81	12
17[3]	3,800	208	18.0	2.94	8.82	90	18
18[3]	7,000	252	27.8	2.98	12.65	96	None.
19	2,200	200	11.0	1.65	3.05	54	7
20[3]	1,400	65	21.5	2.92	9.50	78	None.
21[3]	1,800	80	22.5	1.30	5.52	69	None.
Average	2,499	214	13.1	2.56	8.03	66	-

---

[1] Loaders include all men on loading crews where mechanical loading is employed.

[2] See text.

[3] Mechanical loading.

CONCLUSIONS

In selecting the 21 mines where data for this paper could be obtained, the attempt was made to choose mines with a variety of shaft- and slope-bottom lay-outs and to include mines of all sizes, from a few hundred tons to several thousand tons production per day.

Barrier pillars to protect the shaft or slope at the mines visited vary from 100 feet to 300 feet in width. At mines where no robbing is done and also at some of the old mines, the pillars protecting the shaft or slope bottoms are not uniform in width. The distance from the bottom of the hoist-shaft or slope to the nearest room ranges from 150 feet, at a mine where pillars are not drawn, to over ½ mile at a large mine with 14 main entries and large barrier pillars.

In determining the size of barrier pillars, the following should be considered: Depth of cover, physical character of overlying strata, thickness and physical character of coal seam, and the physical character of the strata underlying the coal seam. It is well to consider the recovery of barrier pillars at the shaft or slope bottom and along the entries at the completion of mining operations. Instead of leaving pillars of the minimum width necessary for protection, they should be made wide enough to be economically recoverable.

Mines 1, 18, and 20 have no interference between loaded and empty car trips on the bottom. Each has two loaded incoming tracks and two empty return tracks. The return empty trips use the locomotive run-arounds for a very short distance, but the empty trips clear this part of the track before the next locomotive arrives for its trip. Mines 4, 5, and 13 also have no interference between loaded and empty car trips on the bottom, but each has only one loaded incoming track and one empty return track. All the other mines have some interference between loaded and empty car trips or at the locomotive run-around, and it is difficult to arrange them into groups. As mines 10 and 15 both use kick-backs on the empty return, they can be classed together and the following summary would result:

Bottom labor-data summary, according to arrangement of track

Number of mines[1]	Average production, tons per shift per mine	Tons of coal per shift per bottom employee handling coal	Track arrangement on bottom
3	4,667	1,078	Two tracks for loads and two tracks for empties. No interference.
3	1,867	622	One track for loads and one track for empties. No interference.
12	2,400	492	Some interference at locomotive run-around.
2	1,135	227	Kick-back for empties; some interference in switching.

[1] Omitting mine 21, where no bottom labor is required.

The following summary gives a comparison of bottom labor handling loaded cars by different methods. (The average number of bottom employees handling loaded cars is two times as great as the number handling empty cars.)

Bottom labor-data summary, according to methods handling loaded cars

Number of mines[1]	Average production, tons per shift per mine	Tons of coal per shift per bottom employee handling coal	Method handling loaded cars on bottom
4	4,275	855	Locomotive.
5	2,420	590	Chain haul or car-feeder.
11	1,952	429	Gravity.

[1] Omitting mine 21, where no bottom labor is required.

Another factor that affects the bottom labor is the type of caging or hoisting, and the following summary shows a comparison of the different methods used at the mines visited.

Bottom labor-data summary, according to type of caging or hoisting

Number of mines[1]	Average production, tons per shift per mine	Tons of coal per shift per bottom employee handling coal	Type of caging or hoisting
4	4,425	1,180	Skip.
10	2,180	490	Automatic caging.
2	1,800	450	Conveyor.
4	1,892	329	Hand caging.

[1] Omitting mine 21, where no bottom labor is required.

The three preceding summaries - arrangement of track, method of handling loaded cars on bottom, and type of caging or hoisting - are probably of equal importance in planning a shaft or slope bottom lay-out. The results shown in these summaries should not be taken as conclusive, as data from additional mines placed in any one group may change the relative position of that group.

Probably none of the shaft or slope-bottom lay-outs included in this paper would fit any other mine, but certain features from the various lay-outs may be helpful in revamping an old lay-out or in planning a new one.

Original from THE OHIO STATE UNIVERSITY